TTO's Office 10S/CA 2712
2718
2719

SERIES 3
ANALOGUE
SCANNER

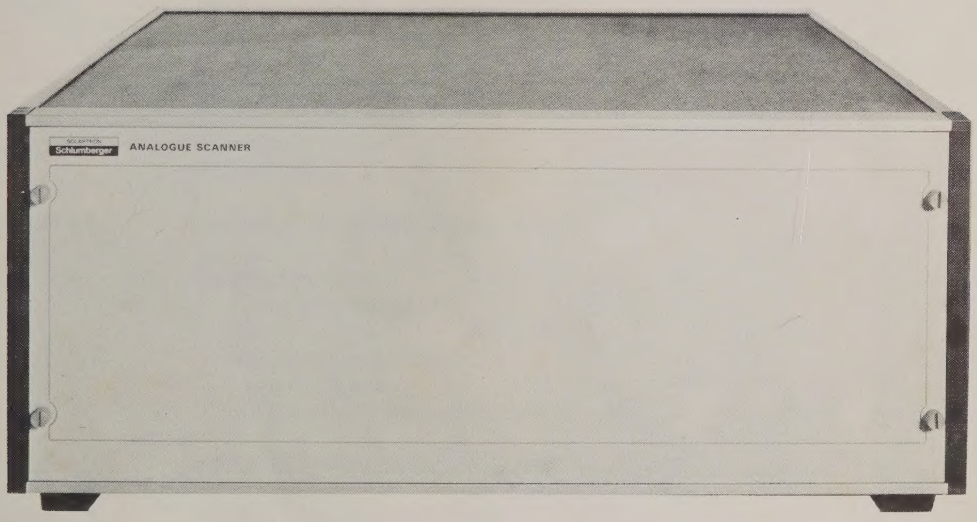
Schlumberger

OPERATING MANUAL

MP MASTER
MA24435

105/CA 2712
2718
2719

SERIES 3 ANALOGUE SCANNER



Part No: 33010070

Date of Issue : July 1974

Schlumberger

THE SOLARTRON ELECTRONIC GROUP LIMITED
FARNBOROUGH HAMPSHIRE ENGLAND GU14 7PW
TEL: FARNBOROUGH 44433 (STD 0252)
CABLES: SOLARTRON FARNBOROUGH HANTS.
TELEX: 85245 SOLARTRON FARNBOROUGH

OPERATING MANUAL

19©74

Printed in England by The Solartron Electronic Group Ltd.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_11399

CONTENTS

		Page
SECTION 1	INTRODUCTION	1.1
SECTION 2	GENERAL DESCRIPTION	2.1
	Introduction	2.1
	Scanner Assembly	2.2
	Basic Scanner Operation	2.4
	Channel Program Addressing	2.7
	Channel Skipping	2.7
	Cold Junction Compensation	2.7
	Strain Gauge Bridge Options	2.8
SECTION 3	TECHNICAL SPECIFICATION	3.1
SECTION 4	INSTALLATION	4.1
	Introduction	4.2
	Module Linking	4.3
	Input Selector Linking Charts	4.4
	Location of Modules	4.7
	Application Mixing	4.7
	System Cabling	4.7
SECTION 5/1	CONTROL INTERFACE 3304	5/1.1
	Introduction	5/1.1
	Linking Instructions	5/1.2
	Analogue Isolation	5/1.2
	Scanner Address	5/1.2
	Selector Module Address	5/1.3
	Signal Conditioning	5/1.4
	Call Program from Channel Address	5/1.5
SECTION 5/2	SELECTOR MODULES 3303/3305	5/2.1
SECTION 5/3	SELECTORS 3307/3308/3309	5/3.1
	Skip Selector Panel 3307	5/3.1
	Program Selector Panel 3308	5/3.1
	Program Selector Panel 3309	5/3.2
SECTION 5/4	STRAIN GAUGE MODULES	5/4.1
	Strain Measurement	5/4.1
	Gauge Factor G	5/4.1
	Strain Gauge Modules 3311/3312/3313/3314/3315/3316	5/4.1
	Input Module 3311	5/4.3
	Bridge Completion Modules	5/4.3
	Module 3312	5/4.3
	Module 3313	5/4.3
	Module 3314	5/4.3
	Control Panels	5/4.3
	Control Panel 3315	5/4.3
	Control Panel 3316	5/4.3

	Selection of Option and Configuration	5/4.4
	Methods of Obtaining the Various Options and Configurations	5/4.5
	Example 1	5/4.6
	Example 2	5/4.7
	Example 3	5/4.7
	Example 4	5/4.8
	Example 5	5/4.8
	Example 6	5/4.9
	Example 7	5/4.9
	Example 8	5/4.11
	Control Interface and Selector Module Linking	5/4.11
	Balance Adjustment	5/4.11
	Scale Adjustment	5/4.11
	Simulating a Calibration Strain	5/4.11
	Setting the Power Supply	5/4.12
	Setting Remaining Channels	5/4.12
	Measuring Strain	5/4.12
SECTION 5/5	**POWER SUPPLY UNITS 3317/3318**	5/5.1
	Introduction	5/5.1
	Input Power	5/5.1
	Output Connections	5/5.2
	Output Controls	5/5.2
SECTION 5/6	**THERMOCOUPLE COLD JUNCTION COMPENSATION UNIT 3310**	5/6.1
	Introduction	5/6.1
	General Description	5/6.2
	Range of Reference Units	5/6.3
	Fitting a Reference Unit	5/6.3
	Programming	5/6.4
SECTION 5/7	**PLATINUM RESISTANCE THERMOMETER POWER SUPPLY 3377**	5/7.1
	Introduction	5/7.1
	Output Connections	5/7.1
	Output Controls	5/7.1

SECTION 1 Introduction

The Series 3 Analogue Scanner is basically an electronically controlled multiposition switch which is used to connect one of a large number of analogue signals to a common point. In most applications the scanner forms part of a data acquisition system containing a digital voltmeter which measures the analogue signals so that they can be recorded. The scanner can also provide signal conditioning for transducers and can call channel programs in a data logging system. The Series 3 Analogue Scanner is fully compatible with the Solartron Compact - 33 Data Logger, Computer Logger and Data Transfer Unit.

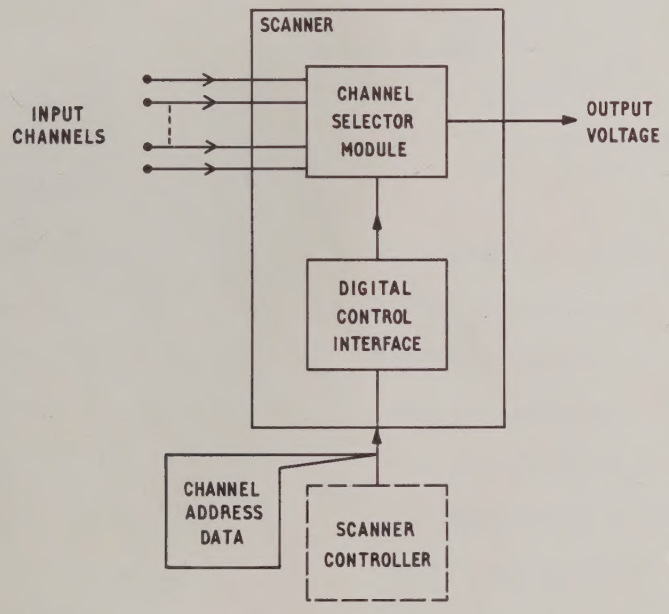


Fig. 1 Scanner: Simplified Block Diagram

A simplified block diagram of the scanner is shown in Fig. 1. The scanner controller is remote from the scanner and normally is part of the logging system. When a channel is to be selected the scanner controller issues the appropriate channel address data to the digital control interface. Decoding of the address data takes place, resulting in the corresponding channel relay being energised. The channel relays are contained in the selector module. When a relay is energised its contacts route the selected input channel to a common output rail.

SECTION 2 General Description

A basic Analogue Scanner comprises a 3301 Mainframe, a 3304 Control Interface and up to ten 3305 or 3303 Input Selectors with 3306 Input Connectors. In addition to these essential modules, a comprehensive selection of options can be used, for such purposes as cold junction compensation, strain gauge bridge completion, and individual channel program addressing. A list of the scanner modules is given in Table 1, and an example of a scanner equipped with most of these modules is shown in Fig. 1 (front view) and Fig. 2 (rear view). For a list of the scanner modules currently available write to Solartron Schlumberger Ltd.

Table 1 *Scanner Modules*

3301 Mainframe

3302 Blank Panel (1.5″ width)

3303 Input Selector 3 pole

3304 Control Interface

3305 Input Selector 4 pole

3306 Input Connector Panel

3307 Skip Selector

3308 Program Selector

3309 Program Selector

3310 Cold Junction Compensator

3311 Input Connector Panel

Strain Gauge Completion Modules:

3312 ½ Bridge Completion Module (No balance, no scale)

3313 ½ Bridge Completion Module (Individual balance, common scale)

3314 ½ Bridge Completion Module (Individual balance, individual scale)

3315 Control Panel (Individual balance, common scale)

3316 Control Panel (Individual balance, individual scale)

3317 Single Power Supply

3318 Twin Power Supply

3320 Scanner Casing

3321 Extension Board for 3304

3325 SALES CODE for 3301 plus 3304 plus 3320

3326 SALES CODE for 3305 plus 3306

3327 SALES CODE for 3303 plus 3306

3373 Strain Gauge Calibration Switch

3374 Dual Current Power Supply

3377 Platinum Resistance Thermometer Power Supply

SCANNER ASSEMBLY

All the scanner modules, with the exception of the self-contained constant current power supplies 3317, 3318, 3374 and 3377, are housed in the 3301 Mainframe. As illustrated in Fig. 2, the 3304 Control Interface, the 3305/3303 Input Selectors and the 3312/3313/3314 Bridge Completion Modules are inserted at the rear of the mainframe, and are secured by means of an appropriate input connector panel (3306 or 3311) or, in the case of the 3304, Interface a cable retaining plate. The 3304 Control Interface must always occupy the position shown in Fig. 2; the other modules, however, can occupy any position in the scanner mainframe. A typical arrangement is shown in Figs. 1 and 2. The 3310 Cold Junction Compensator fixes to the rear of the mainframe by means of an end mounted retaining plate and two knurled screws, and completely covers all the input connector panels.

A printed circuit motherboard within the mainframe provides all the interconnections between the 3304 Control Interface and a) the 3305/3303 Input Selectors, b) the 3312/3313/3314 Bridge Completion Modules. The motherboard is approximately half module height and allows access to the input selectors and bridge completion modules by the front mounted modules shown in Fig. 1. Access to the front mounted modules is obtained by removing the scanner front panel.

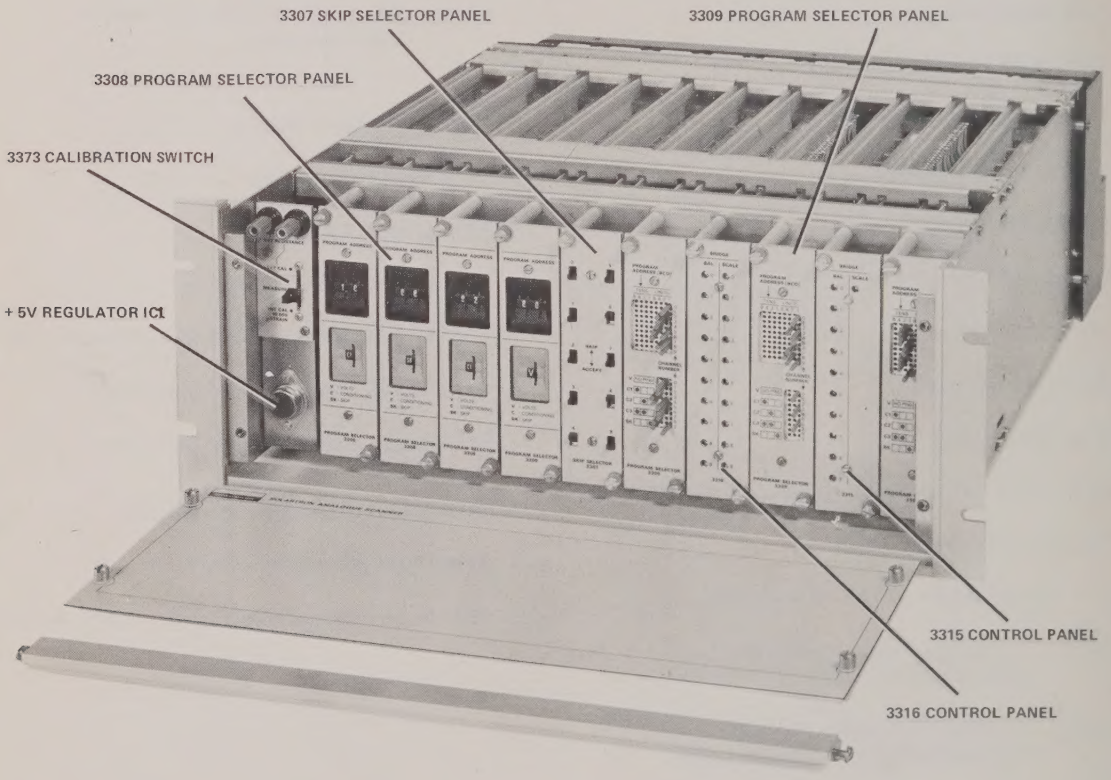


Fig. 1 Scanner : Front View

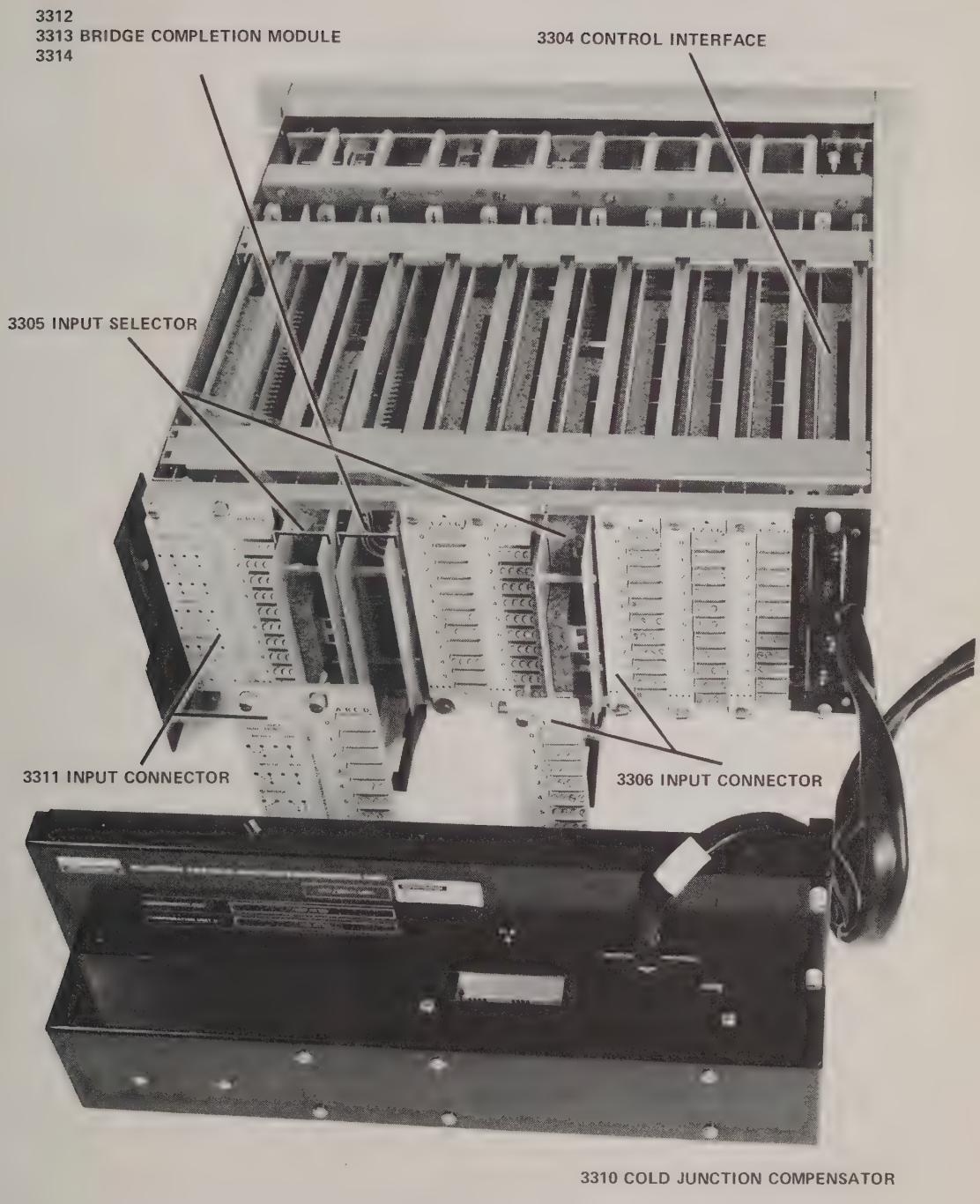


Fig. 2 Scanner : Rear View

BASIC SCANNER OPERATION

The basic scanner circuitry can be divided into two areas - digital and analogue. The digital circuitry performs channel selection, while the analogue circuitry conveys the analogue signal from each transducer input thus selected to a common output.

DIGITAL CIRCUITRY (Fig. 3)

Channel selection is carried out in response to the three BCD decades of channel address which the 3304 Control Interface receives from the scanner controller - 3215 in the case of a DTU and 3353 in the case of Compact 33 and the Computer Logger. Each channel address decade relates to a particular level in the scanner hierarchy: the 'hundreds' decade defines a scanner; the 'tens' decade defines an input selector within that scanner; and the 'units' decade defines a channel within the input selector.

Referring to Fig. 3, the 'hundreds' and the 'tens' decades of channel address are decoded by the 3304 Control Interface. The 'hundreds' decade, via the corresponding 'hundreds address of this scanner' link, allows the control interface to function, while the 'tens' decade, via the 'selector module address' links, calls up a particular input selector. The 'units' decade of channel address is passed by the control interface, unchanged in form, to the input selector called by the 'tens' decade. Here it is decoded to energise the appropriate channel relay.

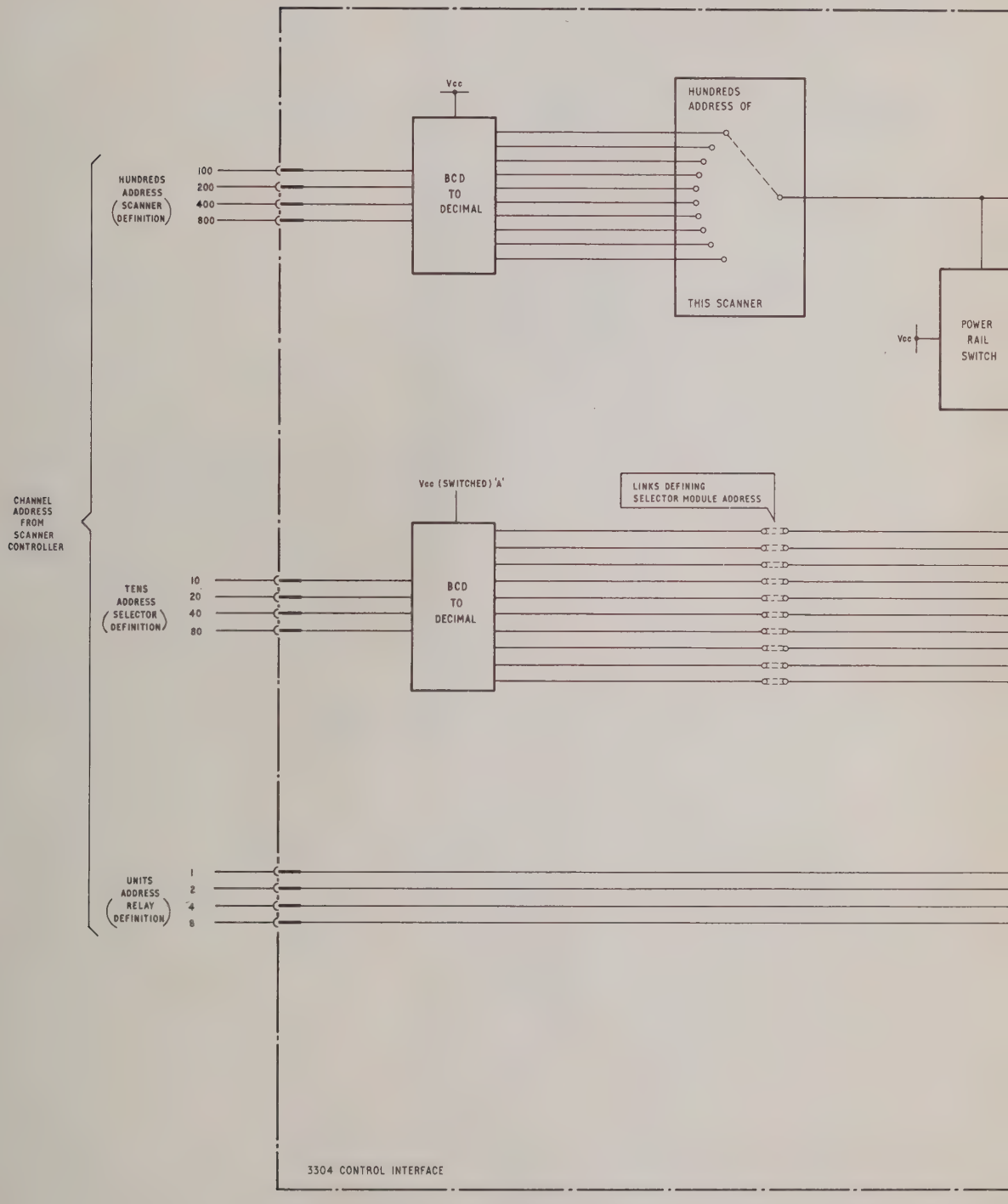
To ensure that a scanner consumes minimum power, the 3304 Control Interface and the 3305/ 3303 Input Selectors each include a power rail switch that is switched on only while the module is responding to a channel address.

ANALOGUE CIRCUITRY (Fig. 4)

When a selector module channel relay is energised the input signal applied to that channel is passed via the relay contacts to analogue bus A or analogue bus B. The choice of whether the signal is fed to bus A or bus B is determined by the position of links on the selector module. Once the choice is made it applies to all channels on that selector module.

The reasons for having both bus A and bus B are twofold. When selector modules are made to work in pairs (for up to eight pole switching) one selector module can be linked to bus A and the other to bus B. Each bus has four lines thus, with this arrangement, eight switched lines are provided. The other reason for having two buses is to enable two types of measuring device to be used.

Because of pick-up and stray capacitance inherent in multi-scanner operation, the outputs from bus A and bus B are taken via contacts of isolation relays. Thus, at any time during operation, only the scanner whose channels are being addressed is connected to the common output lines. The contacts of the isolation relays can be shorted out by links if required (this is done during manufacture for bus A). If more than one scanner is used in the system these links, if present, should be removed.


Vcc
HUNDREDS ADDRESS OF
BCD TO DECIMAL
THIS SCANNER
HUNDREDS ADDRESS SCANNER DEFINITION
100
200
400
800
POWER RAIL SWITCH
Vcc
CHANNEL ADDRESS FROM SCANNER CONTROLLER
Vcc (SWITCHED) 'A'
LINKS DEFINING SELECTOR MODULE ADDRESS
BCD TO DECIMAL
TENS ADDRESS SELECTOR DEFINITION
10
20
40
80
UNITS ADDRESS RELAY DEFINITION
1
2
4
8
3304 CONTROL INTERFACE

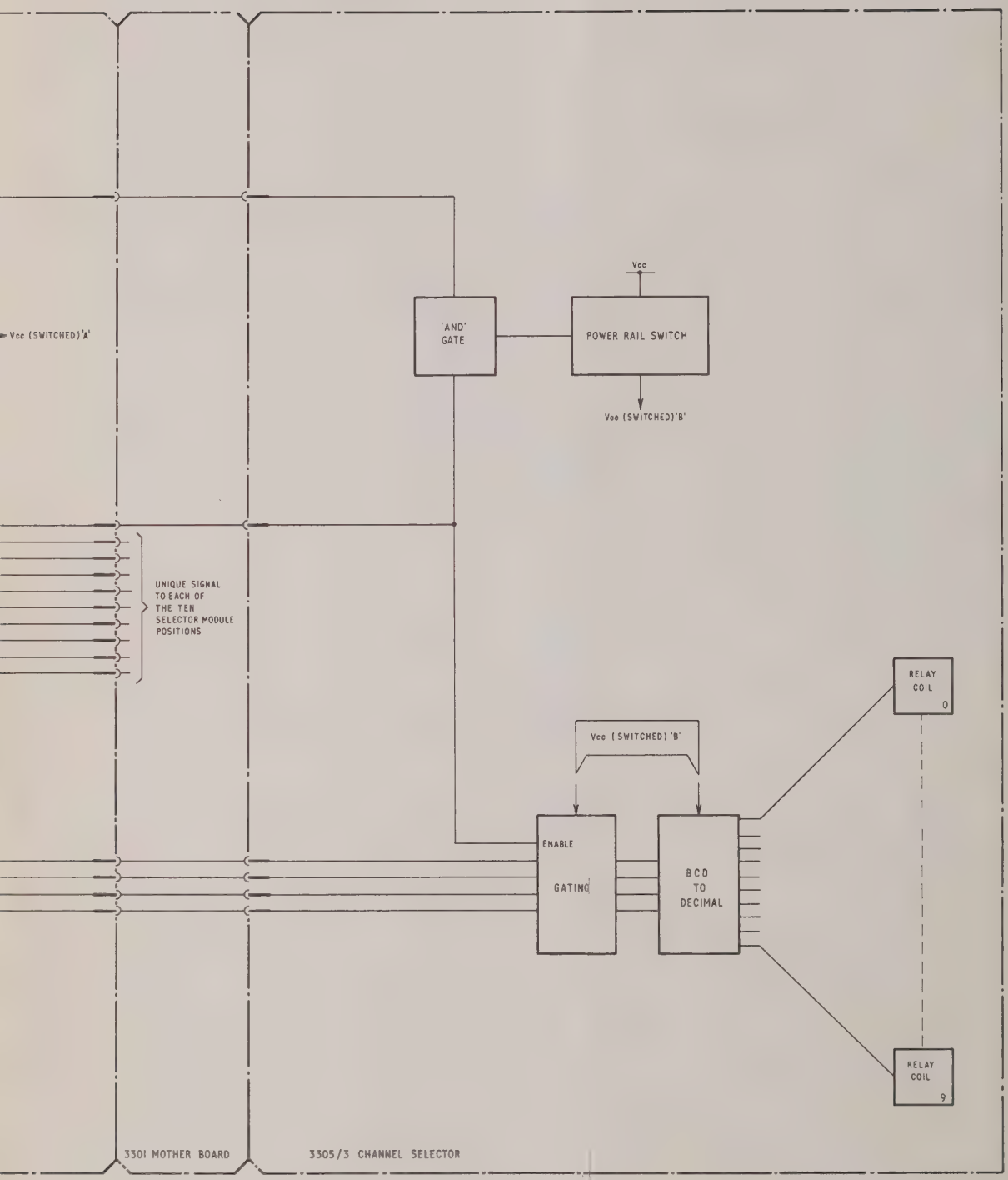
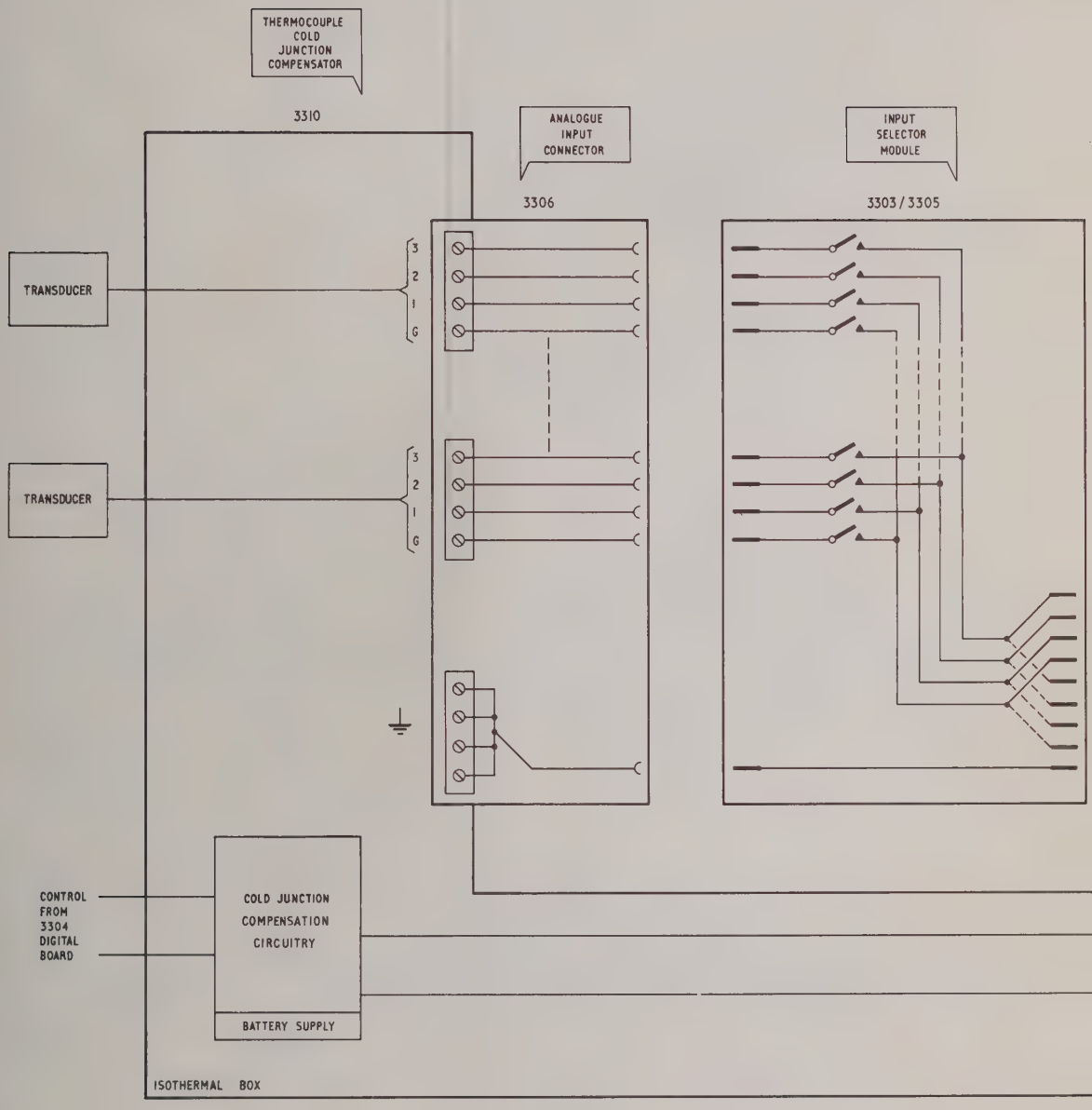


Fig. 3 Scanner Digital Circuitry


THERMOCOUPLE COLD JUNCTION COMPENSATOR
3310
ANALOGUE INPUT CONNECTOR
3306
INPUT SELECTOR MODULE
3303/3305
TRANSDUCER
TRANSDUCER
3
2
1
G
CONTROL FROM 3304 DIGITAL BOARD
COLD JUNCTION COMPENSATION CIRCUITRY
BATTERY SUPPLY
ISOTHERMAL BOX

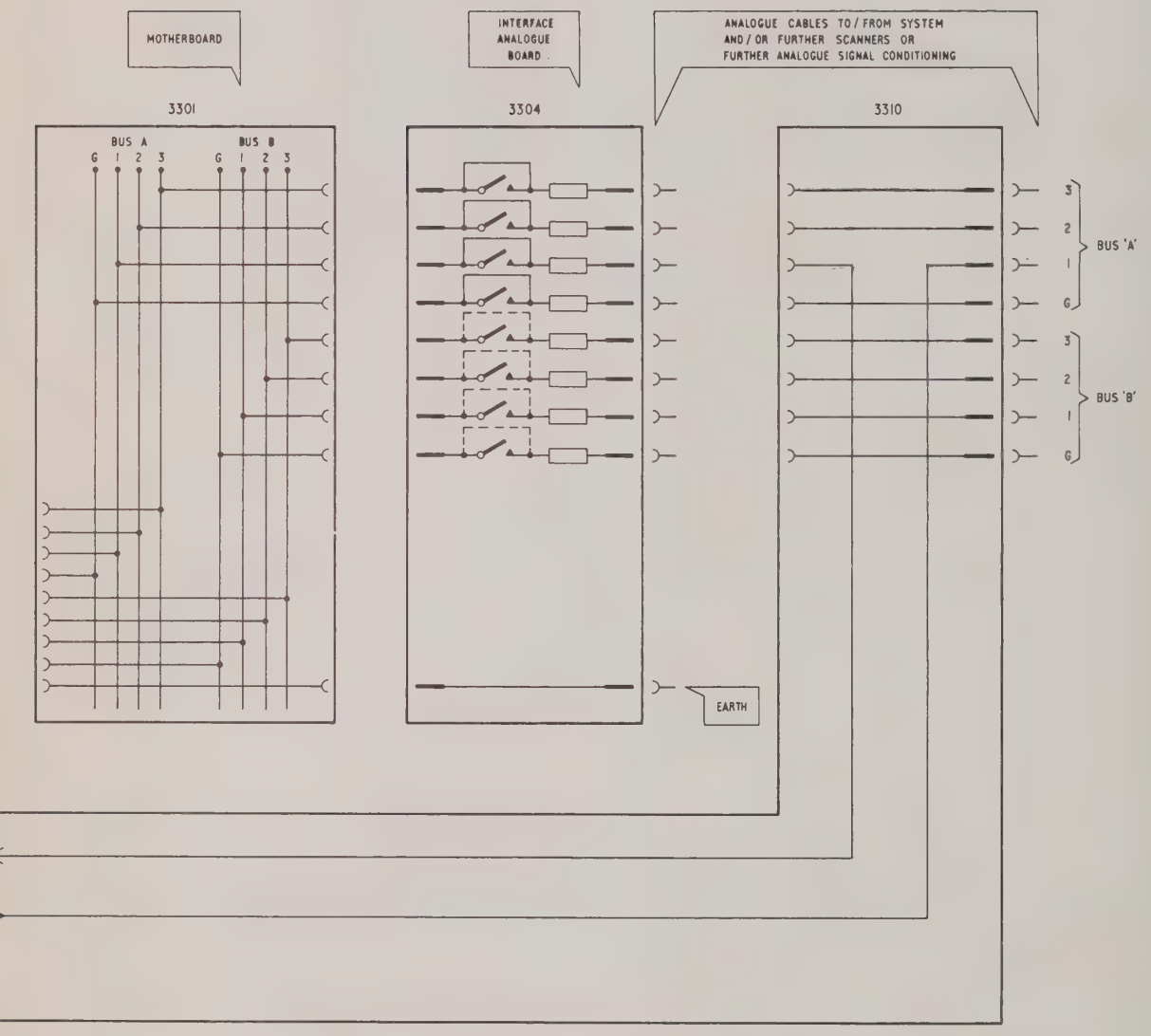


Fig. 4 Scanner Analogue Circuitry

CHANNEL PROGRAM ADDRESSING

Channel program addresses – as used by the Compact - 33 Data Logger – are produced either by the 3304 Control Interface or by a 3308/3309 Program Selector module.

The program addresses produced by the 3304 Control Interface are determined by the *call program from channel address* links – see Section 5/1.

To increase channel programming flexibility, each 3303/3305 Input Selector in the scanner can be used in conjunction with an individual 3308/3309 Program Selector. The 3308 Program Selector provides for the setting up of a program address which, depending on the position of a *channels affected* link at the rear of the module, is common to:-

(a) All channels of the input selector onto which the module is plugged or,

(b) All channels in the scanner.

The 3309 Program Selector enables an individual program address to be set up for each channel of the input selector onto which it is plugged. For details of the 3308 or 3309 Program Selector refer to Section 5/3.

Both methods of producing program addresses can be used in the same scanner. In this case the program addresses from a program selector override any that may be produced by the 3304 Control Interface for the same channel.

CHANNEL SKIPPING

Any unwanted channel in a scanning sequence can be skipped individually by means of a 3307 Skip Selector, or the skip facility on a 3309 Program Selector. A skip facility is also available on the 3308 Program Selector, although this is only applicable to blocks of ten channels or all channels in the scanner - see Section 5/3.

COLD JUNCTION COMPENSATION

Cold junction compensation for thermocouples is provided for by the 3310 Cold Junction Compensator. This unit is in the form of an isothermal box, containing a compensation network, which encloses all the input connectors at the rear of the scanner. The compensation network, when commanded to do so, superimposes a voltage on a thermocouple output that corresponds to the difference in temperature of the cold junctions (input connector terminals) from $0^{\circ}C$.

The compensating network can employ two reference units (sense modules), thus enabling the cold junction compensator to be used with two different types of thermocouple. Reference unit selection is carried out by the *compensation commands* that are produced by:-

(a) The 3304 Control Interface – in which case they are programmed by the *signal conditioning for selector module* links – or,

(b) A program selector module. No *signal conditioning for selector module* links should be fitted for channels where compensation commands are called by a program selector.

Details of the 3310 Cold Junction Compensator are given in Section 5/6, while the *signal conditioning for selector module* links are covered in Section 5/1.

STRAIN GAUGE BRIDGE OPTIONS

In Wheatstone bridge strain gauge applications an Input Selector is paired with one of three types of Bridge Completion Module, each type providing for a particular balance and scale option, as follows:-

3312 - No balance and no scale (option 'A')

3313 - Individual bridge balance and common scale (option 'B')

3314 - Individual bridge balance and individual channel scale (option 'C')

All three types contain ten half-bridge completion circuits which, in conjunction with the dummy resistor circuitry in the 3311 Input Connector, enable each channel of the accompanying Input Selector to be set up for full, half or quarter bridge strain gauges, individually. Details of the linking for this, and for balance range, are given in Section 5/4.

To accomodate an input selector and its companion bridge completion module, the associated *selector module address* links in the 3304 Control Interface are connected to call the two modules simultaneously - see Section 5/1, page 5/1.3.

SECTION 3 Technical Specification

Capacity	10 – 100 channels (in 10 channel groups)
Signal Switching	3 – 8 poles (including guard) per channel
Channel to channel isolation	$> 1000M\Omega < 100pF$
Channel to frame isolation	$> 1000M\Omega < 100pF$
Isolation between any two analogue lines	$> 1000M\Omega$
Reed switching	Operate – all 3 or 4 reeds settle to a bounce-free state in $< 6ms$.
	Release – all 3 or 4 reeds release within 2ms.
Maximum voltage between any pair of inputs or between any input and chassis	200V dc
Maximum steady current through any reed	1.5A
Maximum switched current	150mA
Maximum signal error after thermal stability has been reached	$1\mu V$
or, if used in a multi-scanner configuration employing the isolation relays	$2\mu V$
Operating temperature range	0 to $50^{o}C$
Storage temperature range	-20 to $+70^{o}C$
Humidity	70% RH @ $40^{o}C$
Power requirements	Voltage +9V dc ± 10%
	Quiescent current 60mA per scanner
	Operating current 475mA (4 pole), 650mA (8 pole)
Dimensions	Height 177mm (7in)
	Width 483mm (19in)
	Depth 445mm (17.5in)
Weight	14kg (30lb) average.

SECTION 4 Installation

INTRODUCTION

An Analogue Scanner forms an integral part of the data logging system with which it is used and consideration should be given to the requirements of the system as a whole when installation is carried out. The recommended procedure for installation is as follows:-

1. Program the scanner(s) in accordance with the system requirements - if this is not already done - by means of the linking areas detailed under the heading 'Module Linking'.

2. Connect scanner(s) to the system with appropriate cables supplied. Where an existing system is being expanded, ensure that the maximum allowable length of cable between the most remote scanner and the scanner controller is not being exceeded - refer to information under 'Cable Length Considerations'.

To assist in future system modifications or servicing, it is recommended that a record be kept of the physical layout of the scanning system and of the program linking.

For installation details regarding 3317/3318 Power Supplies, 3310 Cold Junction Compensator, and the 3377 Power Supply, refer to Sections 5/5, 5/6 and 5/7, respectively.

CAUTION Front mounted scanner modules (e.g. 3308, 3316) should not be inserted without the corresponding module (e.g. 3305, 3313) in place to ensure correct alignment.

LOCATION OF MODULES

A cut-away view of the scanner showing module location is given in Fig. 4. Modules are plugged into the scanner chassis from the front and the rear. Program selector panels are plugged in from the front, after removal of the front panel. Input selector modules and the control interface are plugged in from the rear.

MODULE LINKING

To enable the scanner to be set up in accordance with the particular requirements of a logging system, various linking areas are provided on the scanner modules, as indicated in Table 1. If the system requirements are specified at the time of ordering then the modules are supplied linked accordingly; otherwise module linking must be carried out during installation.

Table 1 *Module Linking*

Link Identity	Function	Location	Reference
'Hundreds Address of this Scanner'	Definition of the *hundreds* decade of Channel address to which the scanner will respond.	3304 Control Interface; pcb 33049002	Section 5/1; pp 5/1.2 and 5/1.7.
'Selector Module Address'	Allocation of input selector modules to *tens* decades of channel address.	3304 Control Interface; pcb 33049002	Section 5/1; pp 5/1.3 and 5/1.7.
'Signal Conditioning for Selector Module'	Definition of the signal conditioning, e.g. cold junction compensation, for each input selector module*.	3304 Control Interface; pcb 33049002	Section 5/1; pp 5/1.4 and 5/1.7.
'Call Program from Channel Address'	Derivation of program addresses from channel addresses*.	3304 Control Interface; pcb 33049002	Section 5/1; pp 5/1.5 to 5/1.7 inclusive.
Isolation relay shorting links.	To short out the analogue isolation relay contacts on single scanner systems.	3304 Control Interface; pcb 33049001	Section 5/1; page 5/1.2.
Analogue Bus links.	To determine the routeing of analogue input signals to Bus A and/or Bus B.	3303/3305 Input Selectors; pcb 33039002/33059002.	Section 4; Input Selector Linking Charts.
'Channels Affected'	To allocate a common channel program to, a) all channels in an input selector, or b) all channels in the scanner.	3308 Program Selector; pcb 33089001.	Section 5/3; pp 5/3.1 and 5/3.2.
Strain gauge option links.	To detemine the configuration(s) of Wheatstone bridge strain gauge circuits.	Strain Gauge Modules 3311 - 3314	Input Selector Linking Charts and Section 5/4; pp 5/4.4 to 5/4.6 inclusive and 5/4.10.

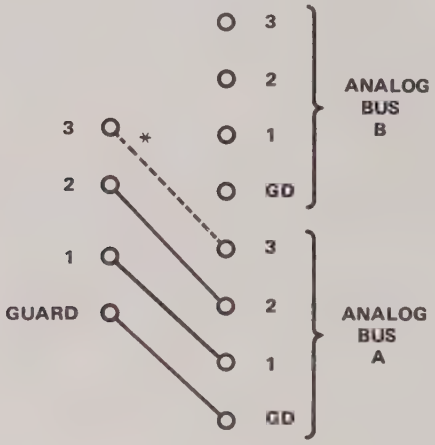
*These functions can also be programmed, with increased flexibility, by the 3308 or 3309 Program Selector panels. Additionally, channel skipping can be programmed - for individual channels using the 3307 Skip Selector or 3309 Program Selector, or for blocks of ten channels (or complete scanner) using the 3308 Program Selector. See Section 5/3.

INPUT SELECTOR LINKING

CHART 1

APPLICATION: Emf measurement only, e.g. thermocouples

ANALOGUE BUS LINKS - pcb 33059002/33039002:



*pcb 33039002 has only three links connected - used on 3303 3-pole Input Selector.

TRANSDUCER CONNECTIONS:

Terminal	Service
1	V+ (signal Hi)
2	V– (signal Lo)
3	
G	Guard

INPUT SELECTOR LINKING

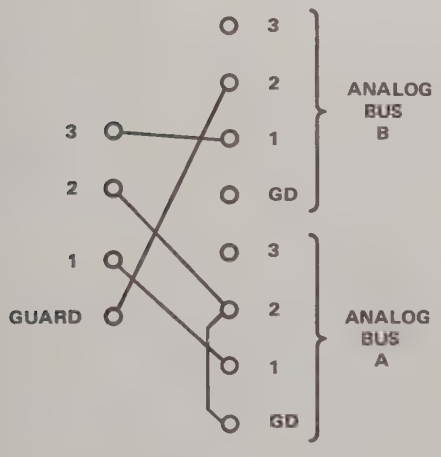
CHART 2

APPLICATION : a) platinum resistance thermometers

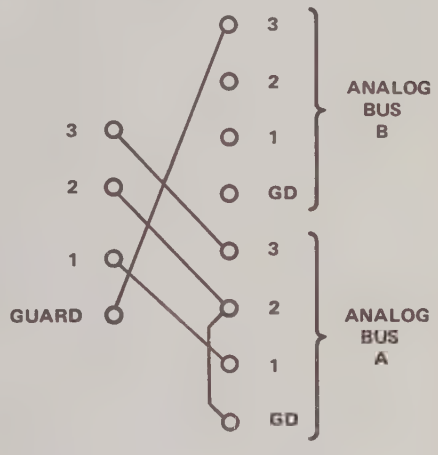
b) linear voltage displacement transducers

c) full (Wheatstone) bridge strain gauges - no balance or scale

ANALOGUE BUS LINKS - pcb 33059002:

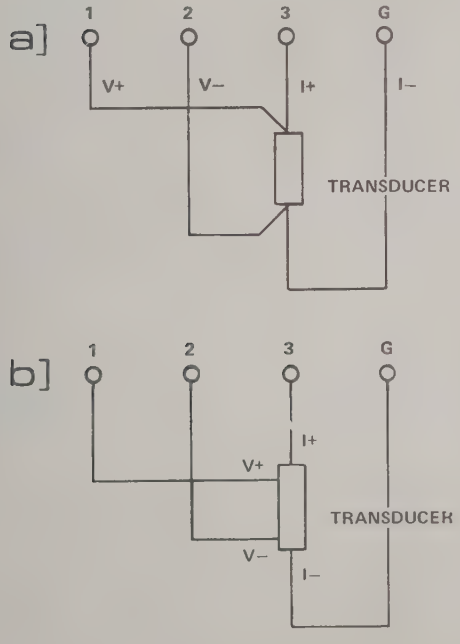


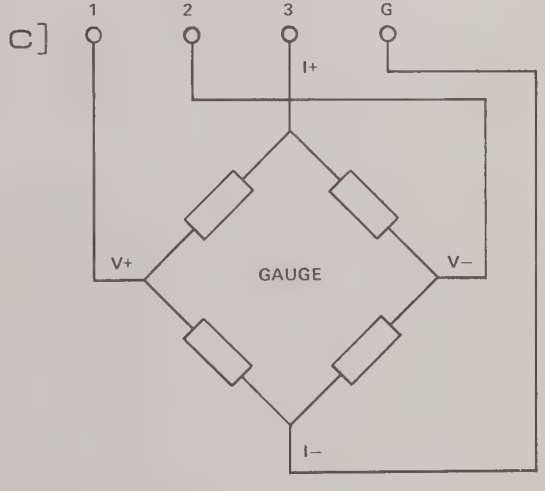
Preferred Linking



Alternative Linking

TRANSDUCER CONNECTIONS:



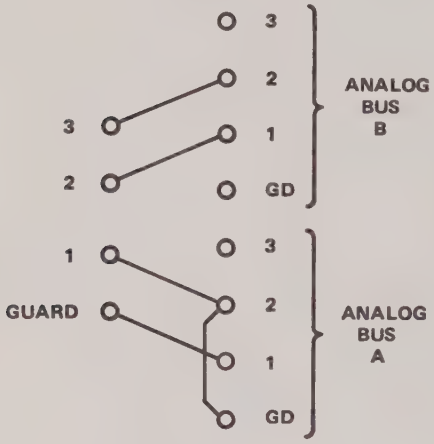


INPUT SELECTOR LINKING

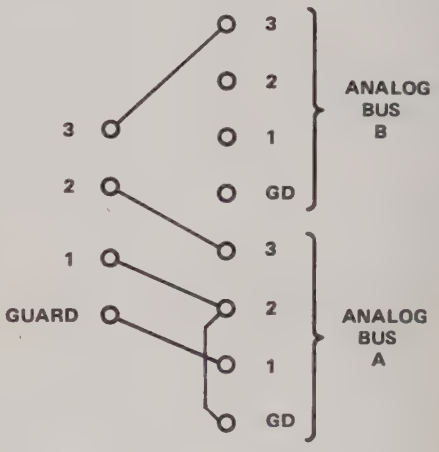
CHART 3

APPLICATION: Full/half/quarter (Wheatstone) bridge strain gauges with balance and scale.

ANALOGUE BUS LINKS - pcb 33059002:

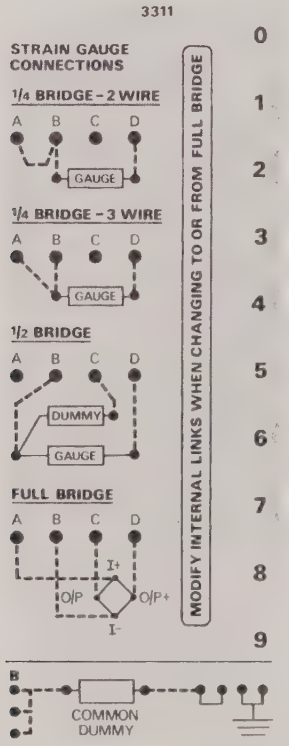


Preferred Linking



Alternative Linking

TRANSDUCER CONNECTIONS:



COMPLETION MODULE LINKING:

Bridge Configuration Links*:-

Configuration	3311	3312/3/4, Board 2
Quarter bridge Half bridge	Link A to C	Link E to D and D to F
Full bridge	Link B to C	No links fitted

*Channel identity indicated by numerical suffix, e.g., D4, E4. F4.

Balance Range Links:-

Contained on board 1 of 3313 and 3314, two links per channel, annotated with channel number:

± 0.3% - no links

± 2.0% - links inserted

NOTE:- For this application the 3305 Input Selector module and its associated Bridge Completion module are addressed as a pair. See Section 5/1 - 'Selector Module Address Links'.

SYSTEM CABLING

Single Scanner

The cable with which a scanner is connected to a logging system plugs directly onto the 3304 Control Interface, being secured there by a cable retaining plate. The location of the various plugs (edge connector type) on the 3304 is shown in Fig. 1. Plugs PLA and PLB are connected in parallel and the associated socket SKA/B on the connector cable can be mated with either one; socket SKA/B carries the digital control signals and the scanner power supply (+9V). Plugs PLD and PLE on the 3304 are also connected in parallel and the associated socket SKD/E on the connector cables carries the analogue signals. Where a 3310 Cold Junction Compensator is in use, plugs PLD and PLE on the 3304 are obscured and the alternative plugs (same identity) on the 3310 must be used.

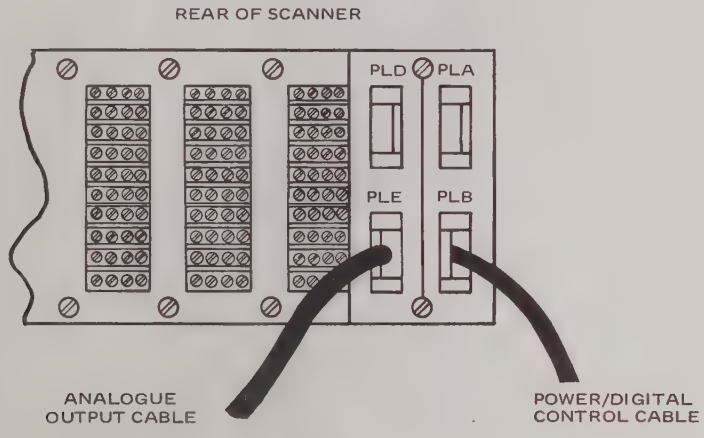


Fig. 1 Single Scanner Connections

The standard scanner cables are listed in Table 2. Cables of extra length can be made to special order and have an L suffix on the type number, e.g. 3390L. Where extremely long lengths of cable are called for, a lower cable resistance can be obtained by connecting the scanners in a 'ring'. In the case of a DTU system a 'forked' cable, type 3382 is supplied for this purpose, and a similar cable for the Compact 33 or the Computer Logger can be made to special order.

Table 2 *Scanner Cables*

No.	Use	
3319	Scanner to DTU and Constant Current Power Supply	
3329	Scanner to C - 33 and Constant Current Power Supply	
3390	Scanner to C - 33	(3′)
3391	Scanner to DTU	(3′)
3392	Scanner to Scanner	(1′- 6″)
3393	Scanner to C - 33	(10′)
3394	Scanner to Scanner	(10′)
3395	Scanner to DTU	(10′)
3282	Scanner to DTU	(forked)

Multiple Scanners

Where several scanners are to be integrated into a system the cables are connected as shown in Fig. 2. With multiple scanner systems the isolation relay shorting links should be removed from all scanners - see Section 5/1, page 5/1.2.

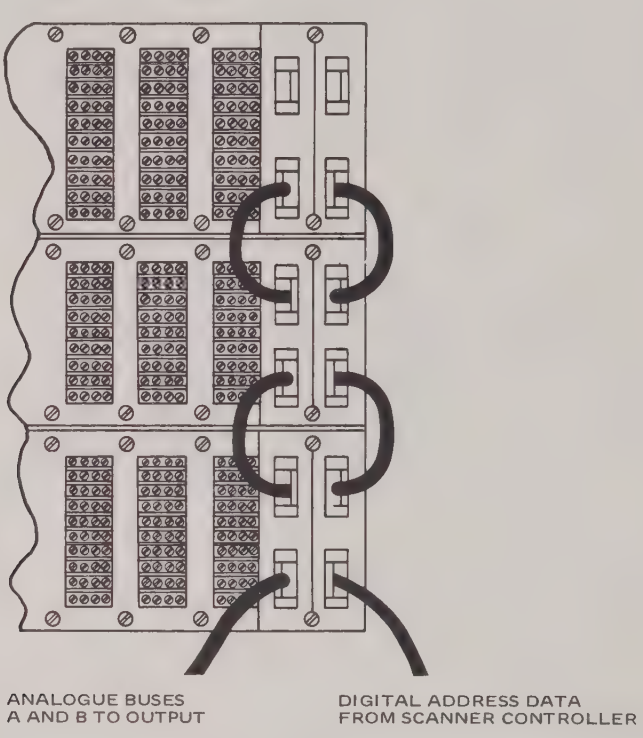


Fig. 2 Multiple Scanner Connections

Cable Length Considerations

Normally a cable of up to 100 metres in length can be used between the scanner controller and the most distant scanner. For cable runs of greater length than this, consideration should be given to the effect of the cable resistance on,

a) the +9V scanner supply, and

b) control signal and analogue signal interference.

The resistance of long cables causes a drop in the supply voltage and for successful operation this should not be less than +7V at any scanner. If necessary, local +9V supplies can be used for distant scanners.

Cable lengths of greater than 100 metres are likely to cause crosstalk in control signal lines or degradation to the analogue signals. These effects can be minimised in most cases, but guidance should be obtained from a Solartron Schlumberger engineer.

Transducer Connections

Transducer connections are made to the input connector panels at the rear of the scanner. Details of the connections for various transducers are given in the Input Selector Linking Charts contained in this section.

The scanner input channels are numbered as shown in Fig. 3. This shows the usual arrangement, but will be varied if any eight pole switching is used. See *selector module address linking*, Section 5/1.

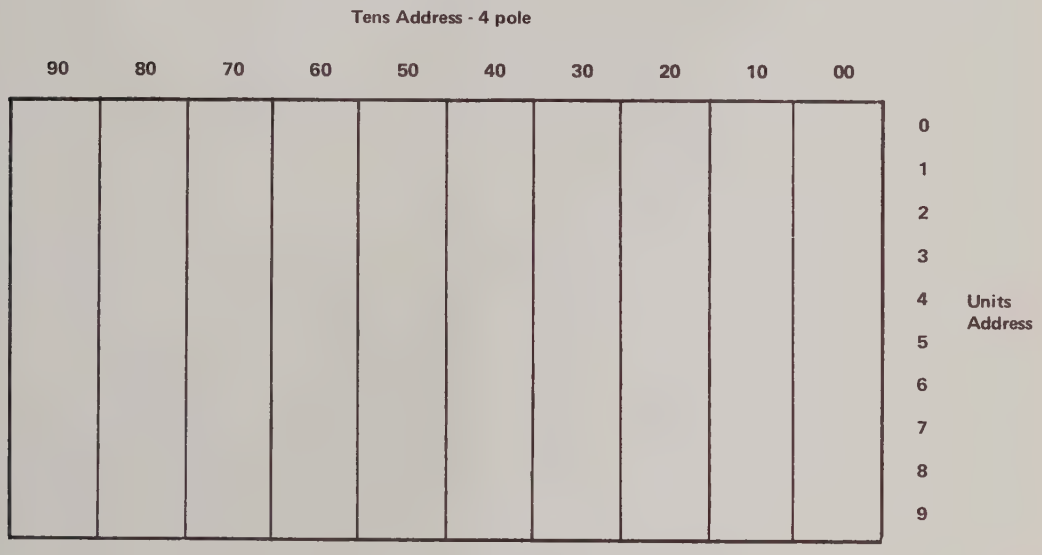
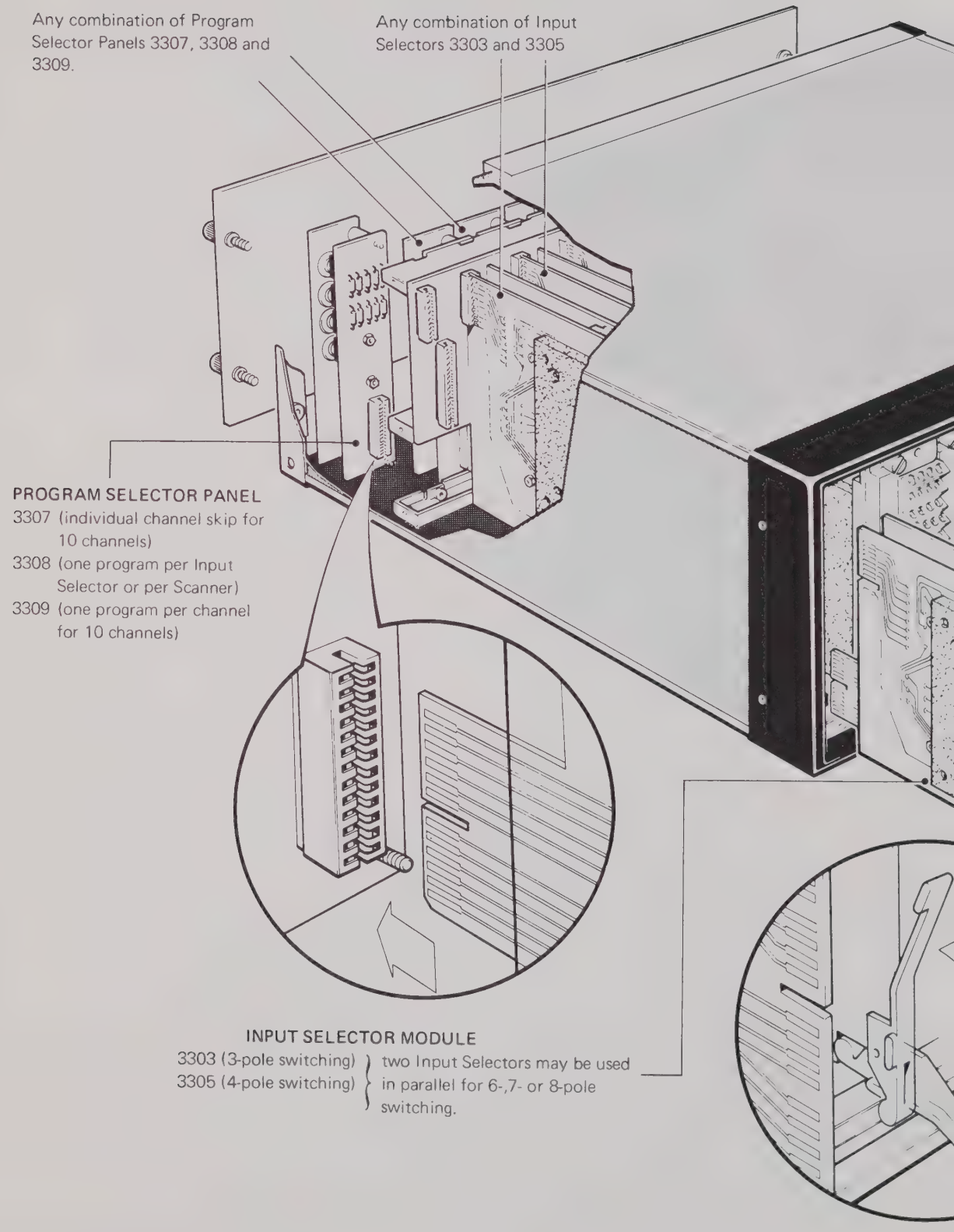


Fig. 3 Channel Numbering

Fig. 4. ⟶


Any combination of Program Selector Panels 3307, 3308 and 3309.
Any combination of Input Selectors 3303 and 3305
PROGRAM SELECTOR PANEL
3307 (individual channel skip for 10 channels)
3308 (one program per Input Selector or per Scanner)
3309 (one program per channel for 10 channels)
INPUT SELECTOR MODULE
3303 (3-pole switching)
3305 (4-pole switching)
two Input Selectors may be used in parallel for 6-,7- or 8-pole switching.

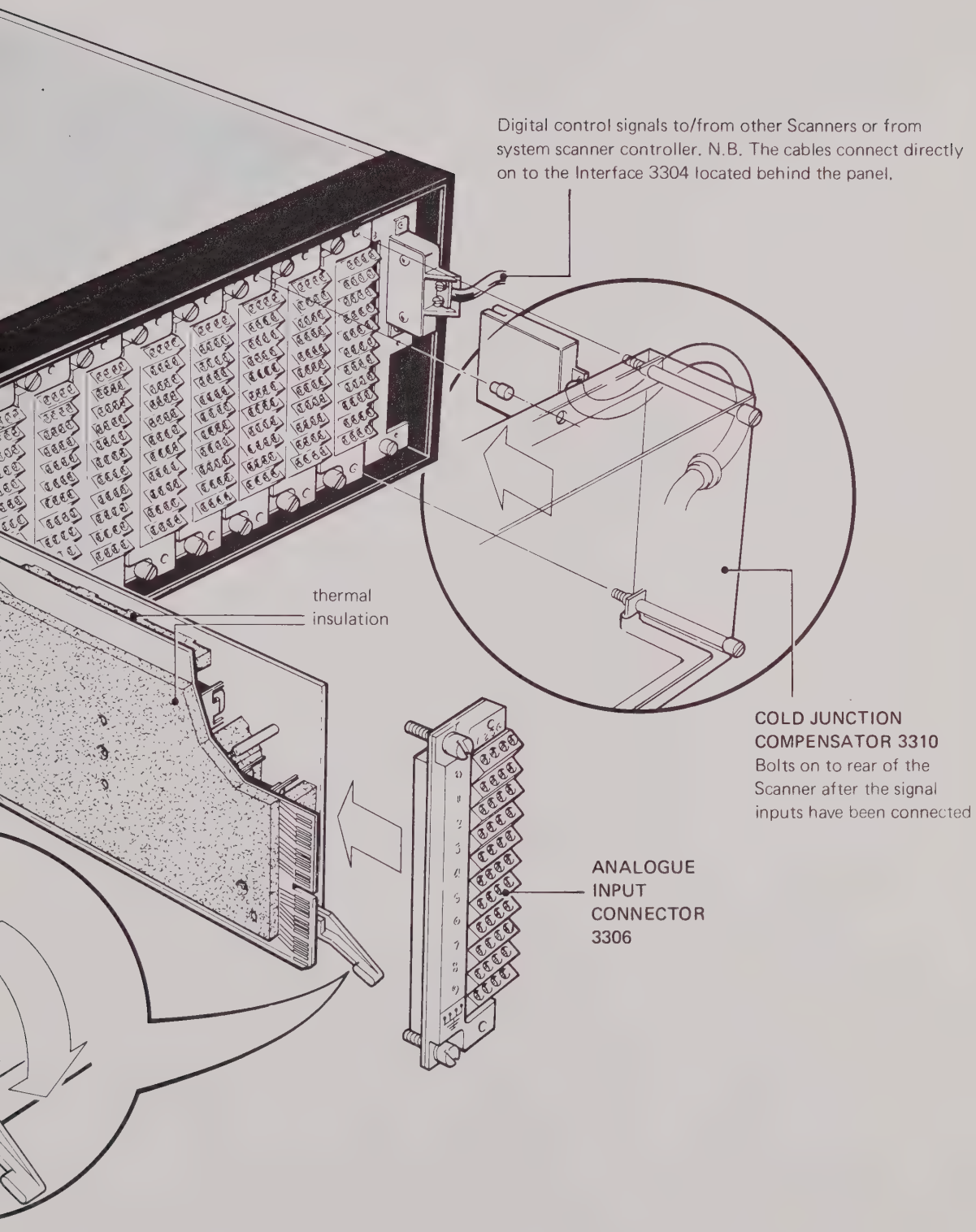

Digital control signals to/from other Scanners or from system scanner controller. N.B. The cables connect directly on to the Interface 3304 located behind the panel.
thermal insulation
COLD JUNCTION COMPENSATOR 3310
Bolts on to rear of the Scanner after the signal inputs have been connected
ANALOGUE INPUT CONNECTOR 3306

Fig. 4 Scanner Assembly

CABLE SCHEDULE : Scanner to C - 33 and Computer Logger

(3329, 3390, 3393)

SKA/B To Scanner (3304)	SERVICE		SKB To 3353 Scanner Controller
18A	100		12A
19A	200		11A
20A	400		14A
17A	800		13A
9B	10		16A
10B	20	Channel	15A
8B	40	Address	18A
16A	80		17A
20B	1		20A
19B	2		19A
18B	4		22A
17B	8		21A
11A	10		5A
10A	20		4A
9A	40		7A
8A	80		6A
		Program Address	
15A	1		9A
14A	2		8A
13A	4		3A
12A	8		2A
2B	Skip/Accept Channel		20B
1B	Common Rail 1		1A
			PLB To 3333 Power Supply
1A			
2A			
3A		+9V	1
4A			
5A			
3B			
4B			
5B		CR2	2
6B			
7B			
16B		Earth	'Amphenol' crimp*

*To earth tag on C-33 chassis - see C-33 Data Logger Operating Manual, page 3.4, Fig. 7.

SKD/E To Scanner (3304)	SERVICE			
	ANALOGUE BUS:		STANDARD ALLOCATION:	
14A	G		DVM Guard	
13A	1	A	DVM Hi	PLA
12A	2		DVM Lo	
11A	3		I_1+	† Spade Term (Red)
2A	G		I_1 and I_2 Guard	† Spade Term (Green)
3A	1	B	I_2+	† Spade Term (Red)
4A	2		I_2-	† Spade Term (Black)
5A	3		I_1-	† Spade Term (Black)

†Spade terminals are fitted, as standard, only to cables 3319 and 3329.

CABLE SCHEDULE : Scanner to DTU

(3319, 3391, 3395, 3282)

Schedule A

SKA/B To Scanner (3304)	SERVICE		PLD To DTU
18A	100		31
19A	200		18
20A	400		32
17A	800		13
9B	10	Channel	29
10B	20	Address	16
8B	40		30
16A	80		17
20B	1		27
19B	2		14
18B	4		28
17B	8		15
2B	Skip/Accept Channel		19
1B	Common Rail 1		35
1A	+9V		1
2A			2
3A			20
4A			21
5A			
3B	CR2		3
4B			4
5B			5
6B			6
7B			7
16B	Earth		8

Cable 3391 and 3395 are as shown in Schedule A; Cable 3282 is a dual version of the same, having two scanner connectors and one DTU connector. Cable 3319 is as shown in Schedule A, but with the additions shown in Schedule B.

Schedule B

SKD/E To Scanner (3304)	SERVICE			
	ANALOGUE BUS:		STANDARD ALLOCATION:	
14A	G		DVM Guard	
13A	1	A	DVM Hi	PLA
12A	2		DVM Lo	
11A	3		I_1+	Spade Term (Red)
2A	G		I_1 and I_2 Guard	Spade Terms (Green)
3A	1	B	I_2+	Spade Term (Red)
4A	2		I_2-	Spade Term (Black)
5A	3		I_1-	Spade Term (Black)

CABLE SCHEDULE : Scanner to Scanner

(3392, 3394)

SKA/B	SERVICE		SKA/B
18A	100		18A
19A	200		19A
20A	400		20A
17A	800		17A
9B	10		9B
10B	20	Channel	10B
8B	40	Address	8B
16A	80		16A
20B	1		20B
19B	2		19B
18B	4		18B
17B	8		17B
11A	10		11A
10A	20		10A
9A	40		9A
8A	80		8A
		Program Address	
15A	1		15A
14A	2		14A
13A	4		13A
12A	8		12A
2B	Skip/Accept Channel		2B
1B	Common Rail 1		1B
1A			1A
2A			2A
3A	+9V		3A
4A			4A
5A			5A
3B			3B
4B			4B
5B	CR2		5B
6B			6B
7B			7B
11B			11B
12B	+5V		12B
13B			13B

SKD/E	SERVICE			SKD/E
	ANALOGUE BUS:		STANDARD ALLOCATION:	
14A	G		DVM Guard	14A
13A	1	A	DVM Hi	13A
12A	2		DVM Lo	12A
11A	3		I_1+	11A
2A	G		I_1 and I_2 Guard	2A
3A	1	B	I_2+	3A
4A	2		I_2-	4A
5A	3		I_1-	5A

SECTION 5/1

Control Interface 3304

INTRODUCTION

This module receives channel address data from the scanner controller and consequently addresses the selector modules contained within the scanner. The 3304 can also call signal conditioning within the scanner, and channel programs in the Compact - 33 data logger. The interface comprises two printed circuit boards, namely, the analogue pcb and the digital pcb. These two boards are assembled together as one unit (Fig. 1).

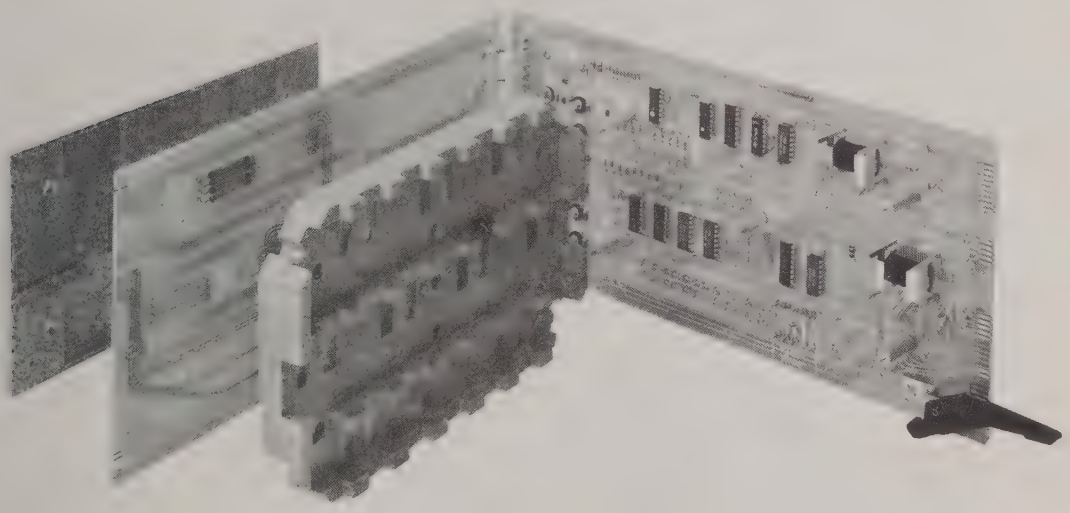


Fig. 1 Dismantled Control Interface

There are comprehensive linking facilities on the interface which, for example, define the hundreds address of the scanner and the allocation of selector modules to the tens decade of channel address. The various linking areas within the interface are shown in Fig. 14.

The interface also contains isolation relays for use when more than one scanner is used in a system. These relays minimise the effects of leakage and capacitance which can cause signal degradation.

LINKING INSTRUCTIONS

Analogue Isolation

During manufacture, the switch contacts of bus A are shorted out by wire links. This is desirable when only one scanner is used in a system, but for multiple scanner operation these links should be removed. A diagram of the links is given in Fig. 2.

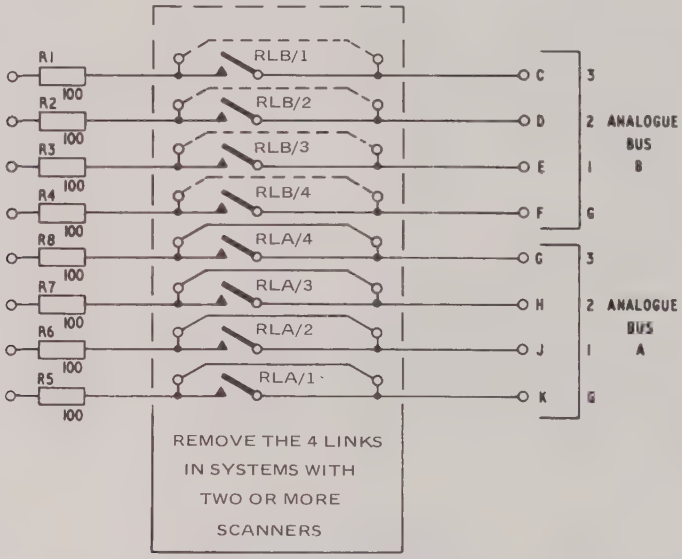


Fig. 2 Analogue Isolation Links

Scanner Address

A given scanner can house channels in any group of hundreds, e.g. 000 to 099, 100 to 199, 700 to 799. The hundreds address of a scanner is defined by the "Hundreds Address of this Scanner" group of pins. All scanners are initially linked to contain the 000 to 099 group of channels (Fig. 3). If it is required to allocate different channel groups to scanners (for multi-scanner operation), then the link must be changed. As an example, Fig. 4 shows the link area connected for addresses in the range 300 to 399.

Note: Only one link should be made in this area.

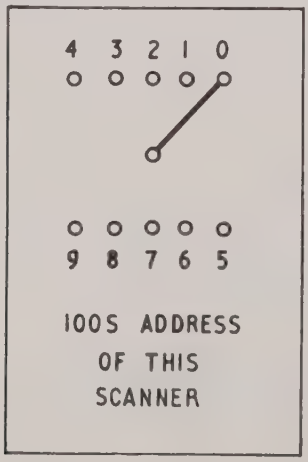


Fig. 3 Standard Linking

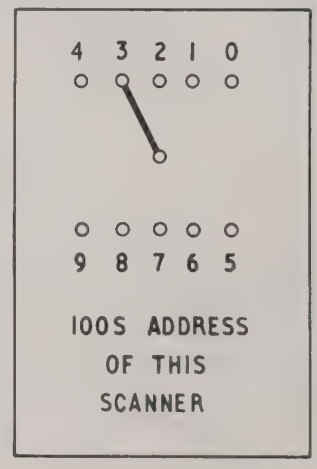


Fig. 4 Linking for addresses 300 - 399

Selector Module Address

Each selector module contains switching for ten channels. The addresses of these channels run from HT0 to HT9, where H is the chosen hundreds address of the respective scanner and T is the tens address of the selector module position. For example if the hundreds address is 3 and the tens address is 5, channels for the selector module in that position would be allocated from 350 to 359.

Tens addresses are allocated to positions in the scanner and therefore to the selector modules plugged into those positions. This allows the selector modules to be interchanged. It also enables two selector modules to operate simultaneously, if required, for up to eight-pole switching. Each of the ten selector module positions is addressed by a signal at a pin in the selector module address link area. Opposite these pins is another set of ten pins which carry signals representing a decode of the tens decade of channel identity. By linking between the two sets of pins, each selector module can be allocated a particular tens address.

The selector module address pins will normally be linked as shown in Fig. 5. This arangement will allow 100 channels of guarded 2 or 3 pole switching, depending on whether a 3 or 4 pole selector module is utilised.

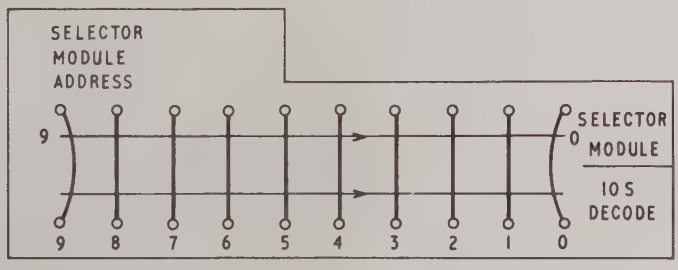


Fig. 5 Selector Module Address: Standard Linking

If different selector module addressing is required, the linking must be changed accordingly. For example, if 20 channels of guarded 3 pole switching and 40 channels of guarded 6 pole switching are required, then two selector modules must operate singly and eight in pairs. The 3 pole channels could be 00 to 19, and the 6 pole channels could be 20 to 59. Fig. 6 shows the necessary linking to achieve this.

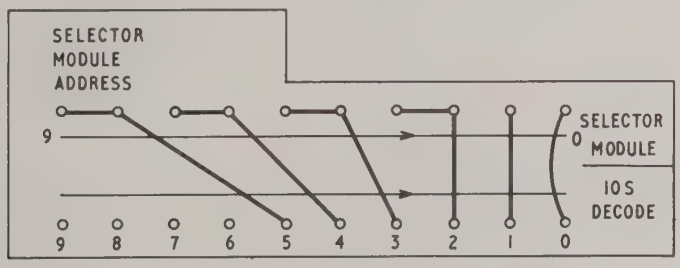


Fig. 6 Selector Module Address: Relay Pair Linking

With this arrangement a total of 60 channels are available. If more are required, a second scanner can be given the same hundreds address as the first and arranged to contain channels in the group 60 to 99 (see Section 4, Multiple Scanners). The appropriate linking for the second scanner is shown in Fig. 7.

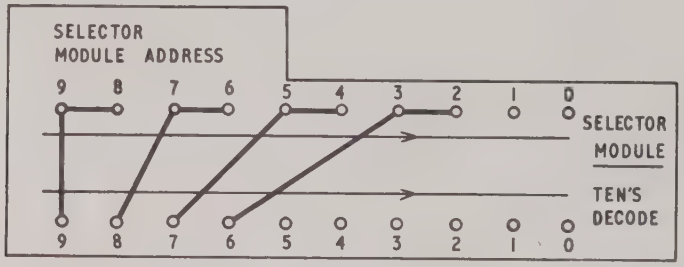


Fig. 7 Selector Module Address: Second Scanner Linking

Signal Conditioning

Signal conditioning can be applied to selected channels either by links on this interface or by program selectors 3308 or 3309.

In many systems, groups of channels may have the same type of transducer inputs and therefore are likely to require the same signal conditioning. Programming for this is determined by the "Signal Conditioning for Selector Module" links. In addition to direct voltage measurement, two types of conditioning are programmable, namely, thermocouple cold junction compensation types 1 and 2. On the link area, pins C1 and C2 represent conditioning for thermocouple type 1 and thermocouple type 2, respectively. Pins 0 to 9 represent the tens address of the selector module to which the conditioning can be applied. Each of these address pins can have one link to one of the two 'conditioning' pins. If an address pin is not linked to a 'conditioning' pin, channels of that module will be available for voltage measurement (no conditioning). If the ALL pin is linked to a 'conditioning' pin, all channels of the scanner will receive that signal conditioning.

For example, in a scanner having a hundreds address of 0, it is required to use channels 000 to 059 for voltage measurement, channels 060 to 079 for thermocouple type 2, channels 080 to 089 for thermocouple type 1 and channels 090 to 099 for voltage measurement. The appropriate linking for this requirement is shown in Fig. 8.

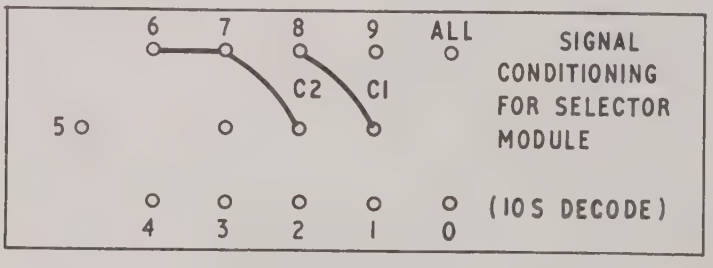


Fig. 8 Signal Conditioning Linking for Blocks of Ten Channels

NOTE:- No *signal conditioning for selector module* links should be fitted for input selectors on which signal conditioning is programmed by a 3308 or 3309 Program Selector.

If conditioning to groups of ten channels is required, but easy selection of this facility is desirable, the use of a 3308 program selector is recommended.

If conditioning of individual channels is required a 3309 program selector must be used.

Call Program from Channel Address

The channel address from the scanner controller becomes the program address via the 'call program from channel address' links (Fig. 9). These links enable the user to call logger programs from channel address, without the use of program selector panels.

Any one or two decades of program address can be produced from the three decades of channel address, in any combination. The linking examples in Figs. 10 to 13 cover the more general requirements and are each illustrated by two diagrams. Diagram 'a' is a simplified theoretical one, whilst diagram 'b' shows the equivalent physical linking requirements.

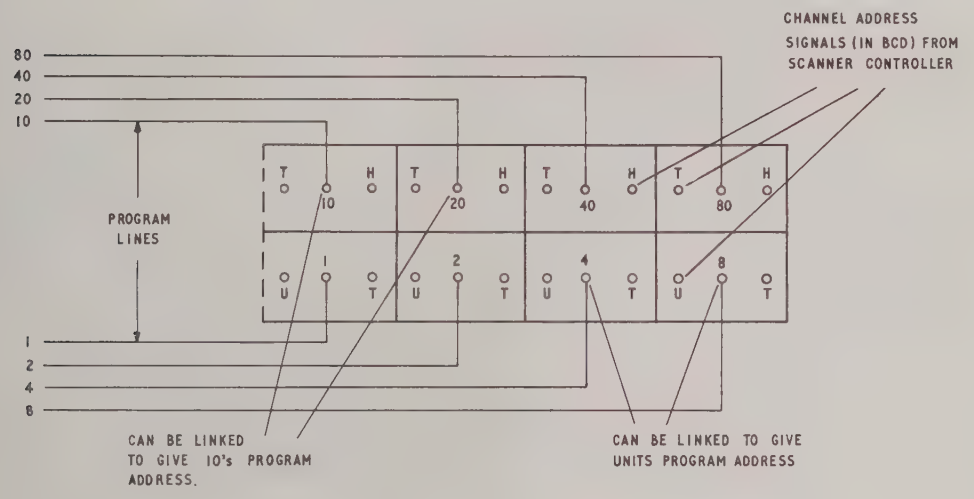


Fig. 9 Call Program from Channel Address Links

Note:

(1) If a program selector panel is used it will override the corresponding program defined in this area.

(2) A link between the INHIBIT pin and the C/R pin inhibits all programs called by links in this area.

Linking Examples

1. In this example it is required that programs are called by the tens and units of channel address, i.e. independent of the hundreds decade. This means that the same series of programs will be called for every hundreds decade of channel address received by the scanner, e.g. the same program will be called from channel addresses 019, 119, 219, 319, etc. The appropriate linking is shown in Fig. 10.

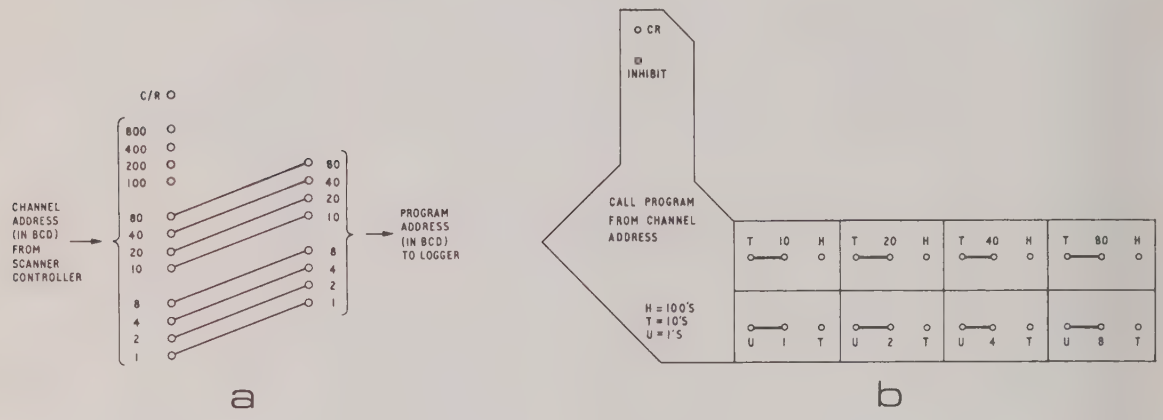


Fig. 10 Linking for Least Significant Two Decades of Channel Address

2. In this example it is required to call programs from the hundreds and tens of channel address, i.e. independently of the units decade. This means that, on a particular scanner, a separate program can be called for each block of ten channels. For example, the program addresses called for channel blocks 000 - 009, 010 - 019, and 020 - 029 are 00, 01, and 02, respectively. Fig. 11 shows the necessary linking.

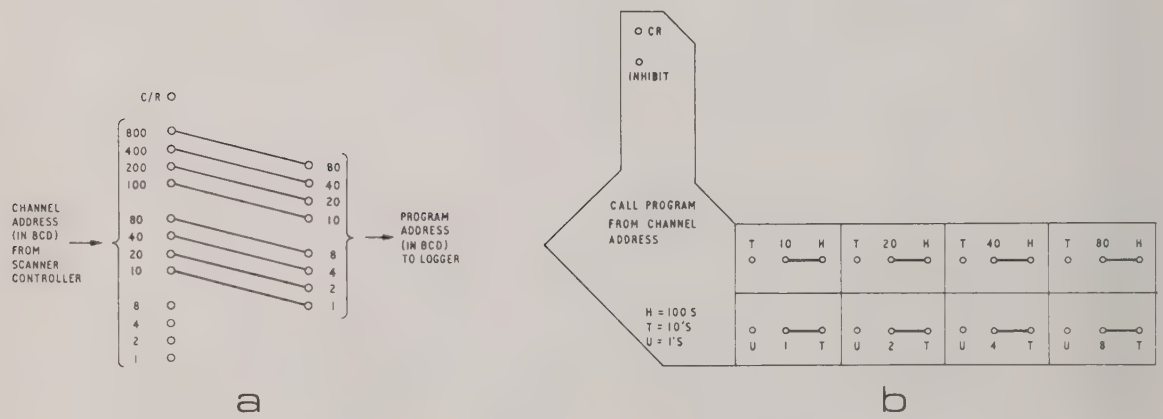


Fig. 11 Linking for Most Significant Two Decades of Channel Address

3. This example is similar to example 2, in that a separate program is called for each block of ten channels. In this case, however, the tens decade of program address is not called by the channel address, but is fixed at '30'. This is achieved by negating the '80' and '40' of program address and leaving '20' and '10' active. Hence the program addresses called for channel blocks '00 - '09. '10 - '19, '20 - '29, etc, will be 30, 31, 32, etc, respectively, for any scanner, regardless of its hundreds address. The appropriate linking is shown in Fig. 12.

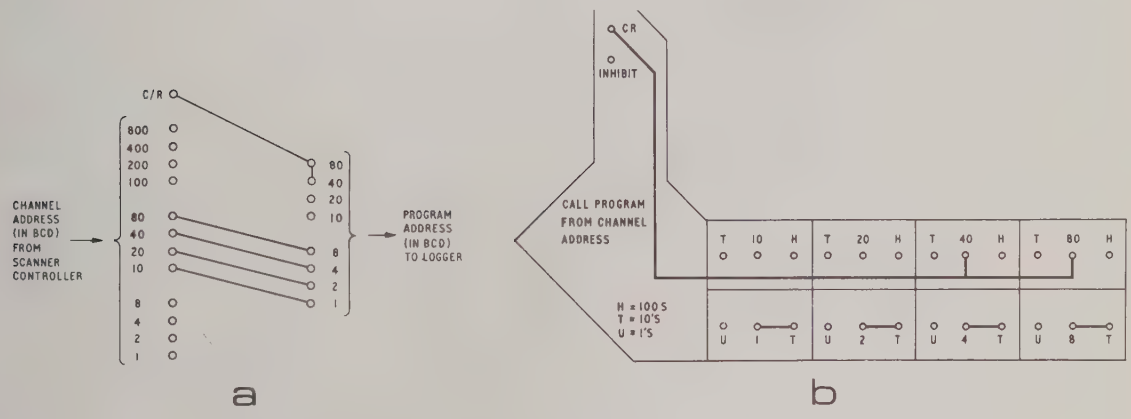


Fig. 12 Negating Link for 40 and 80 BCD Program Address

4. As a further example of that given in 3, programs 80 to 89 are required (one program per selector module). The 8 of the tens decade is generated independently of channel address by using the CR pin to negate 10, 20 and 40 of the bcd program address. Fig. 13 shows the necessary linking.

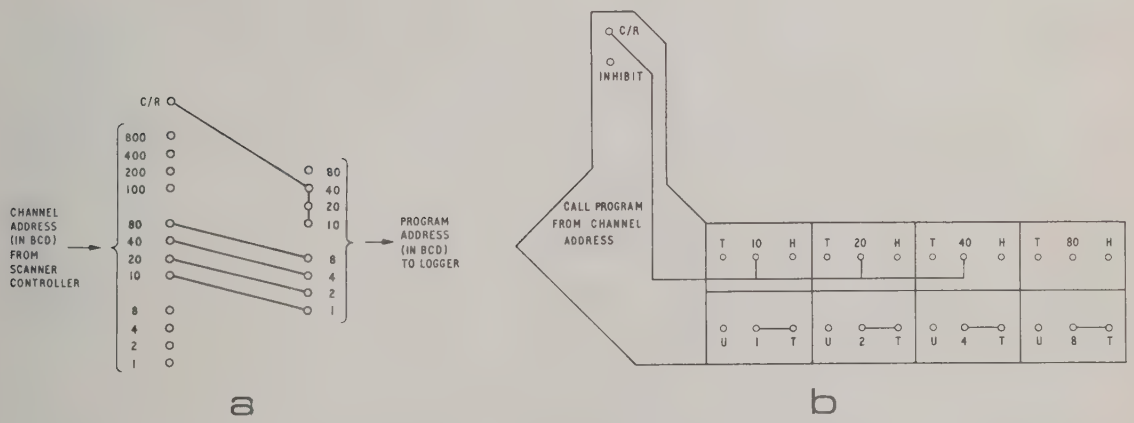
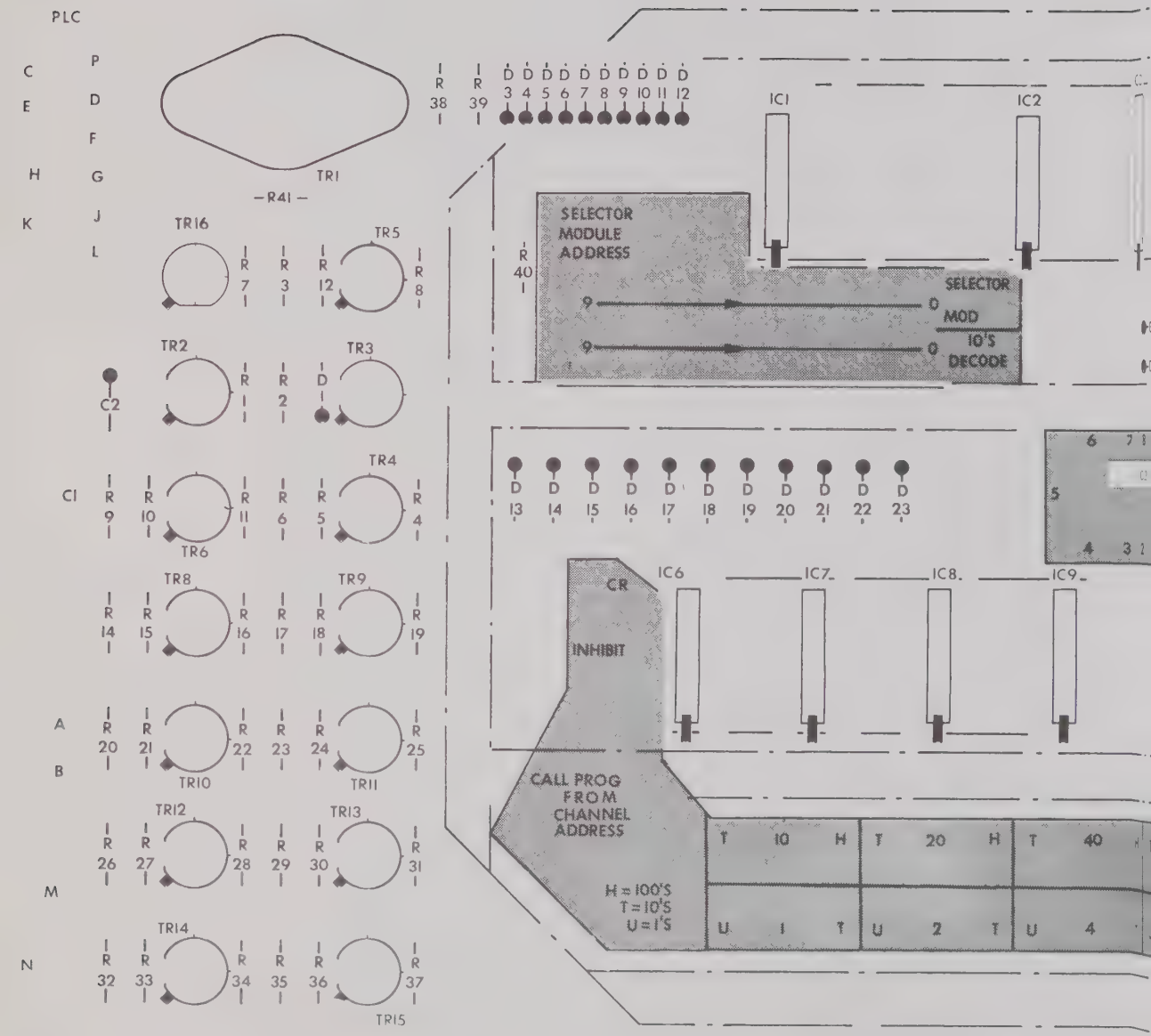


Fig. 13 Negating Link for 10, 20 and 40 BCD Program Address

Note: If it is desired to allocate only one program to a scanner this can be achieved by simply negating the relevant pins of program address as described in Examples 3 and 4, leaving the channel address pins unlinked.


PLC
C
E
H
K
P
D
F
G
J
L
TR1
R41
TR16
TR5
TR2
TR3
C2
C1
TR4
TR6
TR8
TR9
A
B
TR10
TR11
TR12
TR13
M
N
TR14
TR15
R 38
R 39
D 3 4 5 6 7 8 9 10 11 12
IC1
IC2
R 40
SELECTOR MODULE ADDRESS
SELECTOR MOD
10'S DECODE
D 13 14 15 16 17 18 19 20 21 22 23
IC6
IC7
IC8
IC9
CR
INHIBIT
CALL PROG FROM CHANNEL ADDRESS
H = 100'S
T = 10'S
U = 1'S
T 10 H T 20 H T 40
U 1 T U 2 T U 4

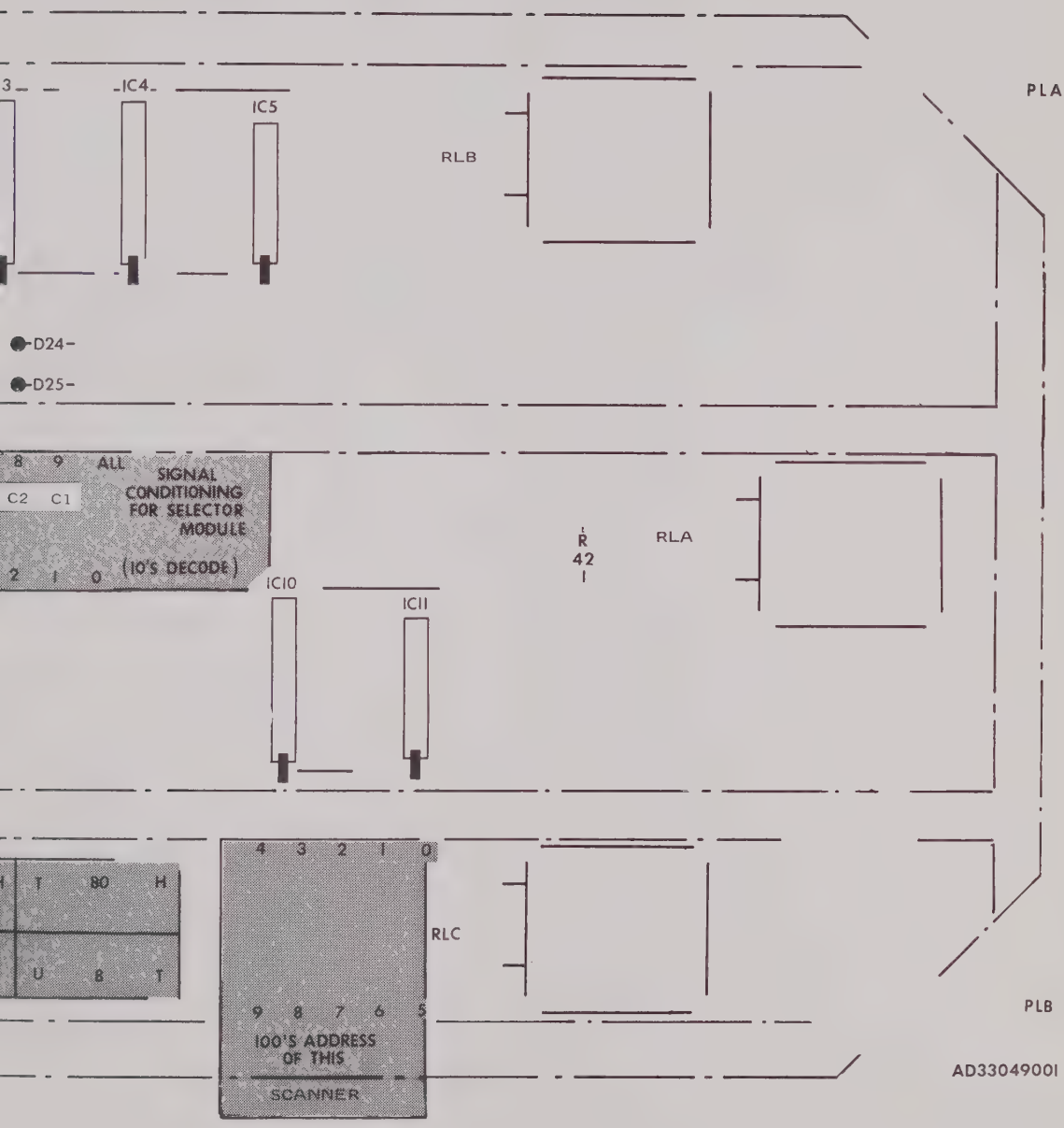


Fig. 14 Interface Linking Diagram

SECTION 5/2

Selector Modules 3303/3305

The purpose of the selector module is to connect analogue input signals to either of two common groups of output lines, when commanded by control signals. Each module contains 10 channels of switching. Selector 3303 provides 3-pole switching; selector 3305 provides 4-pole switching. The module type number is stated on the serial number label.

If a selector module is missing from its position, a signal will be issued from the scanner which will cause the control system to automatically skip the channels associated with that module.

Each selector module occupies 1½in. width in the scanner chassis and comprises two pcb's. One board contains only reed inserts (relay contacts); the other board contains the coils which operate the reed switches, and the associated drive circuitry (Fig. 1).

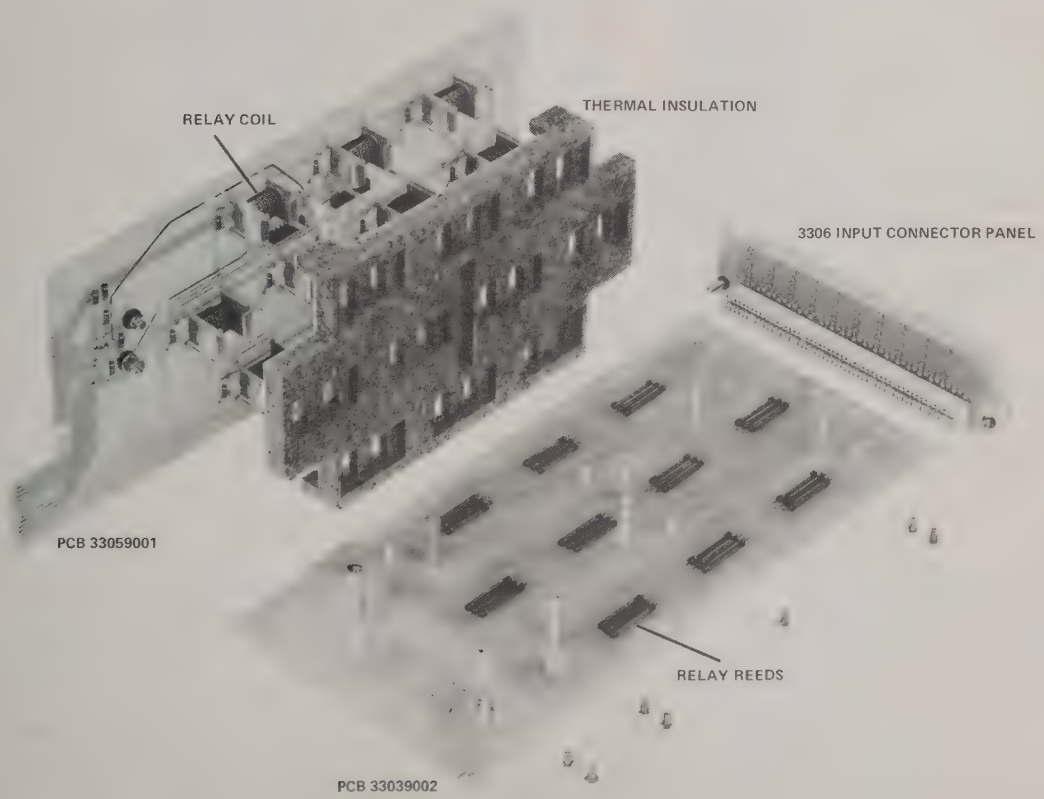


Fig. 1 Dismantled Selector Module

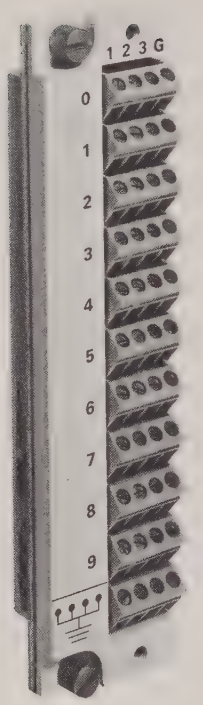


Fig. 2 Analogue Input Connector 3306

Analogue signal connections to each selector module are made via a removable connector panel (3306). Each panel contains 11 four-way screw terminal blocks. A terminal block is used for each channel and the eleventh block provides an earth connection (Fig. 2).

On the board containing the relay reeds are links which determine how the analogue signals are routed to Bus A and/or Bus B. If the application of the input selector is made known at the time of ordering, these links are connected as detailed on the Input Selector Linking Charts contained in Section 4: Installation; otherwise connection is made for emf, as shown in Fig. 3.

Fig. 3 Links for Bus A

SECTION 5/3

Selectors 3307/3308/3309

The program selector panels provide greater flexibility in channel programming than can be obtained with internal linking on the 3304 Control Interface. All three types plug onto the input selector modules at the front of the scanner, behind the face panel - see Section 4, Fig. 5.

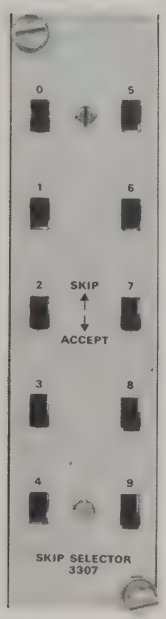


Fig. 1 ***Skip Selector Panel*** *3307*

Fig. 2 ***Program Selector Panel*** *3308*

Skip Selector Panel 3307 (Fig. 1)

This panel enables the operator to preselect any particular channel(s) to be skipped. The term "skip" means the omission of unwanted channels in a scanning sequence. Each panel relates to one selector module and contains ten switches. Each switch relates to one of the ten channels of its associated selector module. If a switch is set to SKIP, the corresponding channel is omitted from the scan.

Program Selector Panel 3308 (Fig. 2)

The program set up on these switches applies to all of the ten channels to which the 3308 is connected. However, by means of a link change, the selected program can apply to all channels in the

scanner, irrespective of the selector module to which the 3308 is connected. This link is located on a board attached to the rear of the selector panel (Fig. 3).

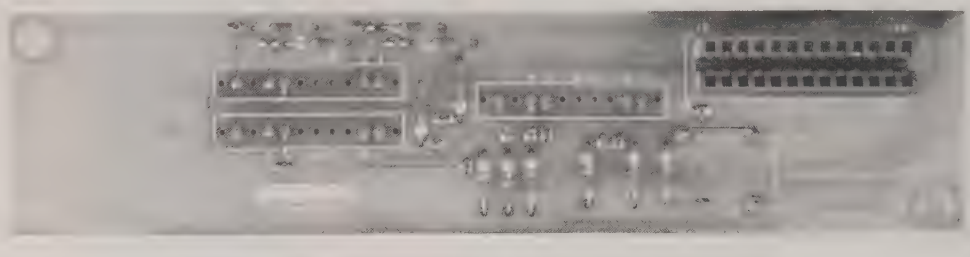


Fig. 3 Rear Board of 3308

The numbers on the upper thumbwheel switch refer to the addresses of channel programs defined in the data logger. For example, if a Compact - 33 data logger is used, the addresses are those of the programs defined on the Programmer 3335 (see Compact - 33 Operating Manual, Section 5). When the channels to which the selector is assigned are scanned, the selected logger program is called.

The lower thumbwheel switch selects the type of signal conditioning. The switch positions are as follows:

V	= Direct (Voltage) measurement – no signal conditioning, no channel skip.
C1 and C2	= Signal conditioning by thermocouple cold junction compensation, reference units 1 and 2, respectively.
C3	= Spare position.
SK	= Channel skip.

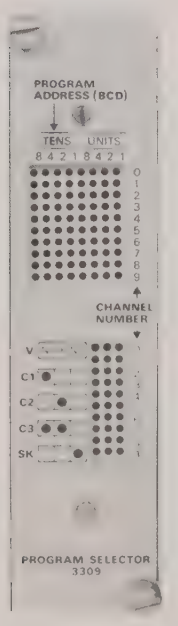


Fig. 4 Program Selector Panel 3309

Program Selector Panel 3309 (Fig. 4)

This selector is similar in principle to the 3308 but allows a unique program to be called for each of the ten channels to which it is connected. Selection is by two pinboards.

The upper pinboard calls programs defined in the data logger, as described for the 3308. It has a row of eight diode pin sockets for each of the ten channels of the associated input selector module. The program address, for each channel, is set by inserting diode pins in a pattern that represents the address in BCD form (diode inserted - logical '1'). A program address of 57 on channel 3, for example, would be set by inserting diode pins into row '3' in the following positions: 'Tens 4' and 'Tens 1'; 'Units 4', 'Units 2' and 'Units 1'. Any program address between '00' and '99' can be set up in this way.

The lower pinboard selects signal conditioning if required. It has three bits for each channel. As illustrated on the front panel, the left-hand two columns are for thermocouple cold junction compensation. The third column is for programming channel skip, i.e. the insertion of a diode pin will cause that channel to be skipped. The significance of V, C1, C2, C3 and SK are as described for the 3308.

SECTION 5/4 Strain Gauge Modules

STRAIN MEASUREMENT

Various methods of measuring mechanical strain are used, the most common employing a device whose electrical resistance changes when subjected to mechanical strain; these devices are called strain gauges.

A strain gauge, usually in the form of a resistance film on a thin substrate, is intimately bonded to the structure to be tested. When load is applied to the structure the strain is transmitted to the gauge, this causes a change in its resistance which is linearly proportional to the strain. The constant relating the change of resistance to strain is called the GAUGE FACTOR.

The change in resistance of the strain gauge is measured and can be scaled to give a direct reading of strain.

Various methods of measuring the resistance change could be used, but the simplest and most widely used employs a Wheatstone bridge (Fig. 1).

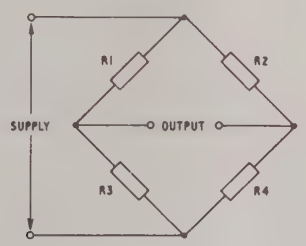


Fig. 1 Wheatstone Bridge : Basic Circuit

Typically for strain gauge measurement, three of the resistors are fixed and the fourth is the strain gauge. If the three resistors are suitably chosen, the output measured is proportional to the change of resistance of the gauge and thus the strain.

Additional circuitry may be added to the basic bridge to provide adjustments for scaling and zero balance. The operation of the bridge is basically unchanged by these additions.

Gauge Factor G

Strain = S
Initial gauge resistance = R
Change of gauge resistance due to strain S = $\triangle R$

$$G \times S = \frac{\triangle R}{R}$$

Strain Gauge Modules 3311/3312/3313/3314/3315/3316

In its strain gauge scanning form the 'Series Three' Analogue Scanner comprises a 3325 basic assembly into which are inserted sets of strain gauge modules together with 3305 input selector modules (Fig. 2).

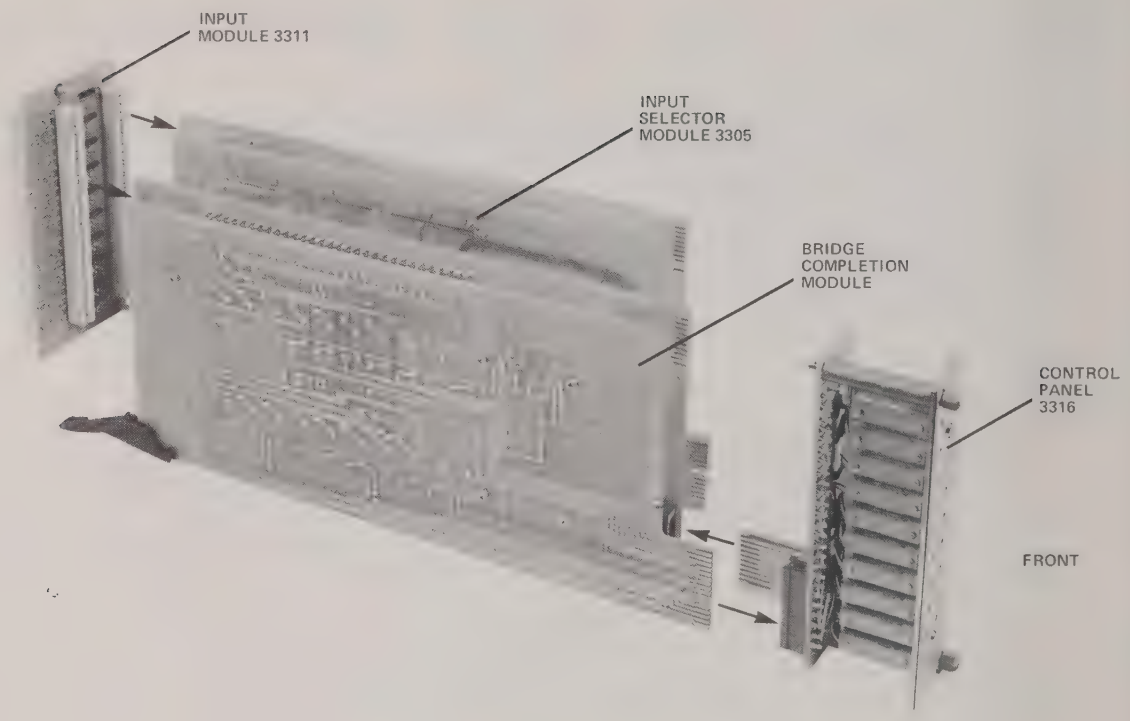


Fig. 2 . A Typical Arrangement of Strain Gauge Modules

Each set of strain gauge modules provides for 10 strain gauge inputs; one 3325 assembly can provide for a maximum of 50 strain gauge inputs.

The use of strain gauge modules in the scanner does not affect its other logging functions, and use can still be made of the 3307 skip selector panel, the 3308 and 3309 program selector panels and the 3310 cold junction compensator unit.

Ten strain gauge channels occupy the same space as twenty standard input channels. Table 1 shows the number of input channels available in one 3325 assembly where a mixture of strain and normal inputs exist.

Table 1

No. of Strain Inputs required	No. of Standard Inputs	Total Number of Inputs
0	100	100
1 - 10	80	90
11 - 20	60	80
21 - 30	40	70
31 - 40	20	60
41 - 50	0	50

The selector module address links on the 3304 Digital Interface must be linked in pairs to accomodate the double module required for strain gauges. Fig. 6 on page 5/1.3 illustrates the method.

Three options of strain gauge modules are available, each option providing for full, half or quarter bridge configurations, thus making a total of 9 variations of strain gauge available.

Option A - No balance, no scale, intended for computer logger use.

Option B - Individual balance and common scale.

Option C - Individual balance and individual scale.

The sets of strain gauge modules for each option are shown in Table 2.

Table 2

Option	Input Module	Bridge Completion Module	Control Panel
A	3311	3312	-
B	3311	3313	3315*
C	3311	3314	3316

*A 3316 Control Panel may be used, in which case the 'Channel 0' scale potentiometer acts as the common scale potentiometer.

In addition a constant current supply (400μA to 30 mA) is required to energise the bridge circuit; this can be obtained from either the 3317 (single) or 3318 (double) strain gauge power units (Section 5/5).

INPUT MODULE 3311

This contains:-

(1) A group of 11 4-way connectors. Ten of these provide the terminations for the strain gauges and any external elements of the bridge, e.g. dummy gauge for ½ bridge configuration. The remaining connector provides connections for an external common dummy gauge (fixed resistor or unstrained gauge), and an earth connection.

(2) The connectors required for coupling the bridge completion module to the input selector module.

(3) Ten resistors which act as dummy gauges in the normal ¼ bridge configuration, (standard dummy gauge 120 ohms).

BRIDGE COMPLETION MODULES

Module 3312 contains 20 resistors which form the bridge completion networks for 10 strain gauge channels. The resistors are grouped in matched pairs.

Module 3313 contains the same components as the 3312 plus 40 resistors to provide a balance facility for each channel, and a relay drive circuit and resistor to provide a common scaling facility for the ten channels.

Module 3314 contains the same components as the 3312, 40 resistors to provide a balance facility for each channel and 10 resistors to provide a scaling facility for each channel.

CONTROL PANELS

The balance and scaling controls associated with options B and C are mounted on panels that plug onto the front of bridge completion modules 3313 and 3314.

Control Panel 3315 (Fig. 3) contains ten controls for balance and one for scaling.

Control Panel 3316 (Fig. 4) contains ten controls for balance and ten for scaling.

Fig. 3 Control Panel 3315

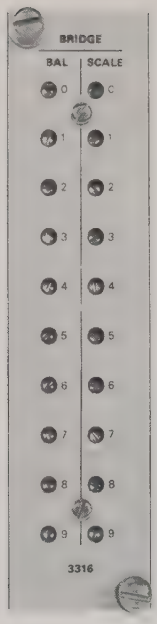


Fig. 4 Control Panel 3316

SELECTION OF OPTION AND CONFIGURATION

The scale facility is used to correct for gauges having small differences of gauge factor. It consists of a variable resistor connected across the constant current supply to each bridge circuit.

Option B provides a common scale control for the ten channels. It is used when the strain gauges for each channel of a group of ten channels are identical.

Option C provides a scale control for each channel and is used when the strain gauges are not identical.

Having chosen the option, three basic configurations are available. Table 3 lists the modules and their respective linking for the required option and configuration.

The terms 'full bridge', 'half bridge' and 'quarter bridge' refer to that part of the bridge which is external to the scanner.

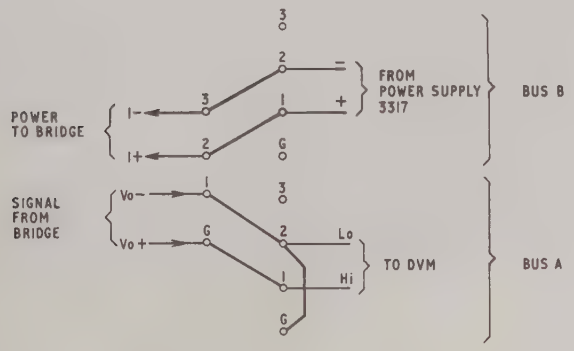
Table 3

Module Linking

<table>
<tr><th colspan="2"></th><th>3311</th><th>3312, 3313 and 3314</th></tr>
<tr><td>Quarter bridge</td><td>2 wire
3 wire</td><td rowspan="2">Link pins
C to A</td><td rowspan="2">Link pins E to D to F</td></tr>
<tr><td>Half bridge</td><td>3 wire
4 wire</td></tr>
<tr><td colspan="2">Full bridge</td><td>Link pins
B to C</td><td>No links</td></tr>
</table>

ANALOGUE BUS LINKING (3305)

The analogue bus requirement for strain gauge measurement is two lines for the constant current supply and two lines for measurement of the bridge output. Details of the standard bus links on board 33059002 which fulfil this requirement appear in Input Selector Linking Chart 3 (Section 4 : Installation). The following diagram illustrates the function of the preferred analogue bus linking.



METHODS OF OBTAINING THE VARIOUS OPTIONS AND CONFIGURATIONS

The following examples show the variations available. Examples 1 to 6 illustrate the various bridge configurations without balance and scale, 7 and 8 cover the balance and scale options. It should be noted that 7 and 8 can be combined with any of the configurations shown in 1 to 6. Fig. 5 and 6 show the physical connections and linking required for the various configurations.

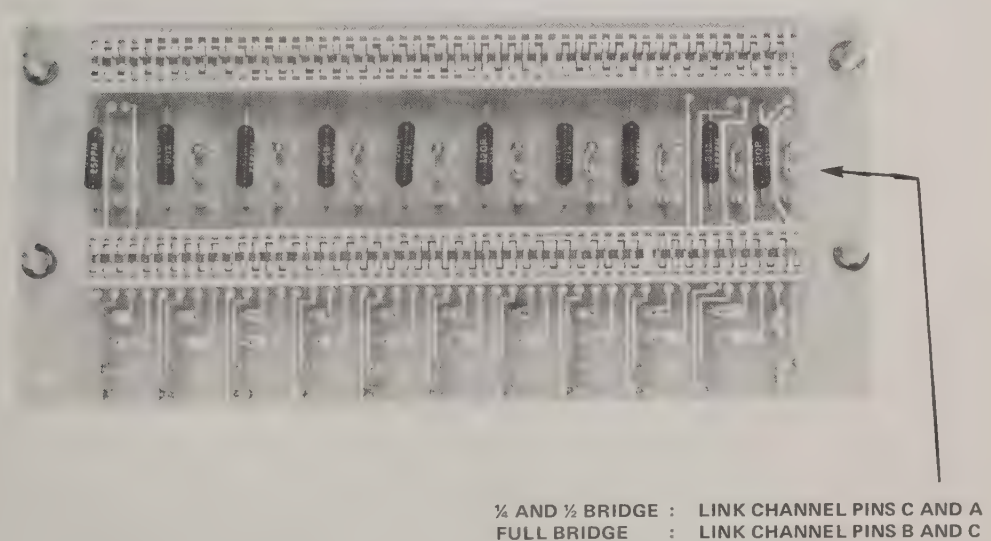


Fig. 5 Input Module 3311

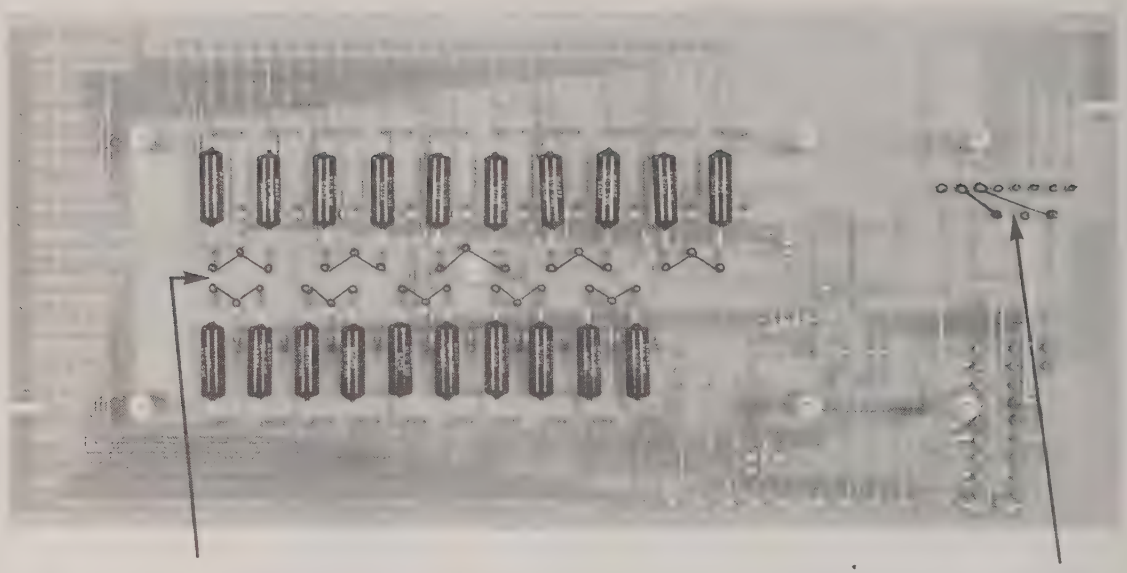

MODULES 3312, 3313 AND 3314,
CHANNEL PINS E, D AND F:-
¼ AND ½ BRIDGE : LINKS AS SHOWN
FULL BRIDGE : NO LINKS
STANDARD LINKING:
LINK PINS H AND Q
LINK PINS J AND R
(THESE SHOULD NOT
REQUIRE CHANGING).
COMMON DUMMY
LINKING : M TO S

Fig. 6 Bridge Completion Module (Board 2) : Link Areas

EXAMPLE 1 (Fig. 7)

Option A - no balance - no scale - quarter bridge - two wire.

The module supplies components for three arms of the bridge, i.e. R1 and R2 on the bridge completion board and R3, the dummy strain gauge, mounted on the 3311 module. R4 is the strain gauge.

In the two-wire system an error is introduced which is due to the variability of the lead resistance in one arm of the bridge. This system can be used without serious error if only a short lead is required to connect the strain gauge, otherwise, the three-wire system is recommended - see Example 2 (Fig. 8).

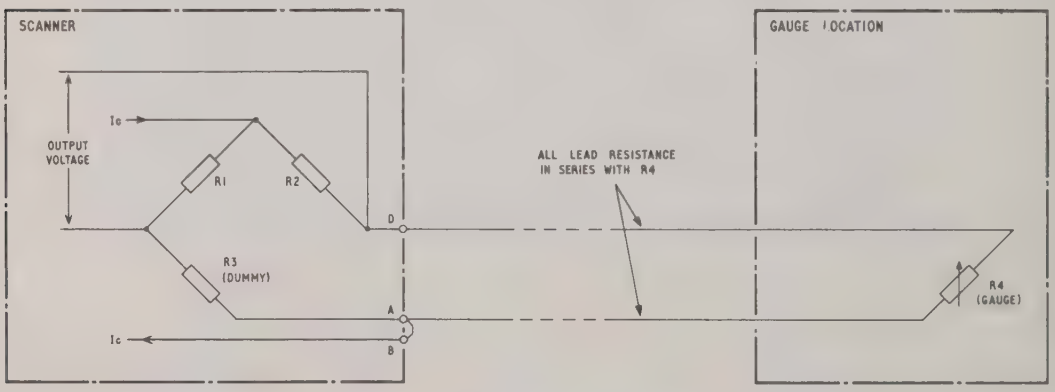


Fig. 7 Quarter Bridge, 2 Wire

EXAMPLE 2 (Fig. 8)

Option A - no balance - no scale - quarter bridge - three wire.

In the three wire system a similar long connecting wire is introduced into the opposite arm of the bridge, therefore any spurious resistance in the leads will be self cancelling. This third lead carries the bridge current and does not affect the measurement.

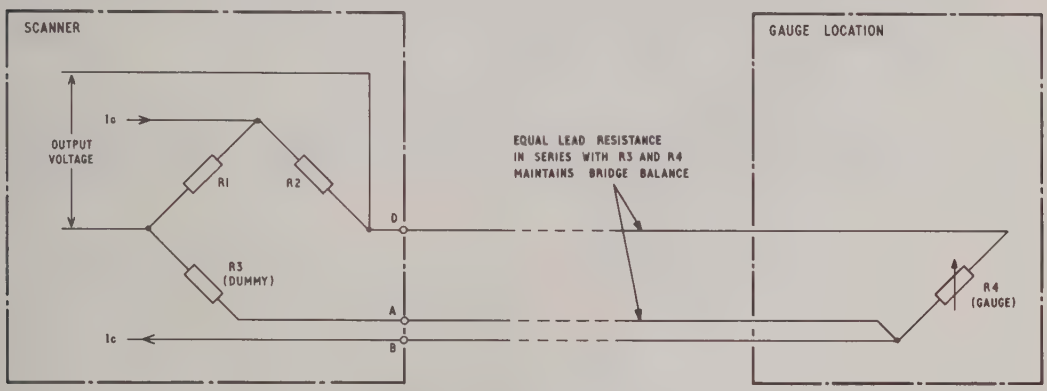


Fig. 8 Quarter Bridge, 3 Wire

EXAMPLE 3 (Fig. 9)

Option A - no balance - no scale - quarter bridge - common dummy.

The modules supply components for two arms of the bridge, i.e. R1 and R2, on the bridge completion board. The common dummy resistor is external to the modules and may be mounted in a location best suited to the user. The gauge should be connected as for standard quarter bridge use. One or more groups of bridges may be connected for common dummy operation in a system while other bridges are connected as standard half or quarter bridge networks.

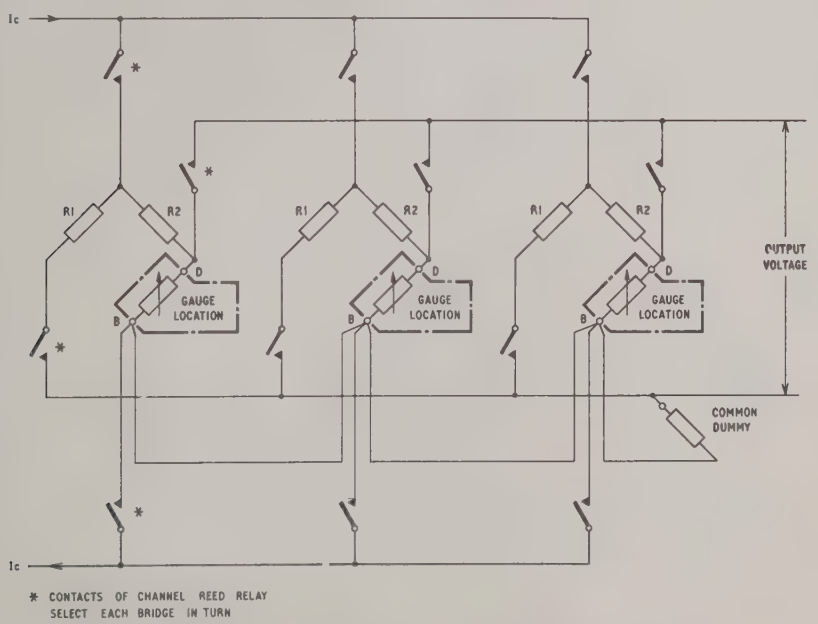


Fig. 9 Quarter Bridge, Common Dummy

Common dummy operation introduces two disadvantages as follows:

(1) Compensation for differing leads to gauges is more difficult.

(2) A relay contact is introduced into the active bridge circuit.

The effects of the relay contact is minimised by the best choice of its position in the circuit and the quality of relays chosen. However, common dummy operation of this type is not generally recommended.

EXAMPLE 4 (Fig. 10)

Option A - no balance - no scale - half bridge - three wire.

Resistors R1 and R2 are located on the bridge completion module. Dummy gauge R3 is fitted adjacent to R4 thereby avoiding errors due to the temperature difference of R3. R4 and their leads.

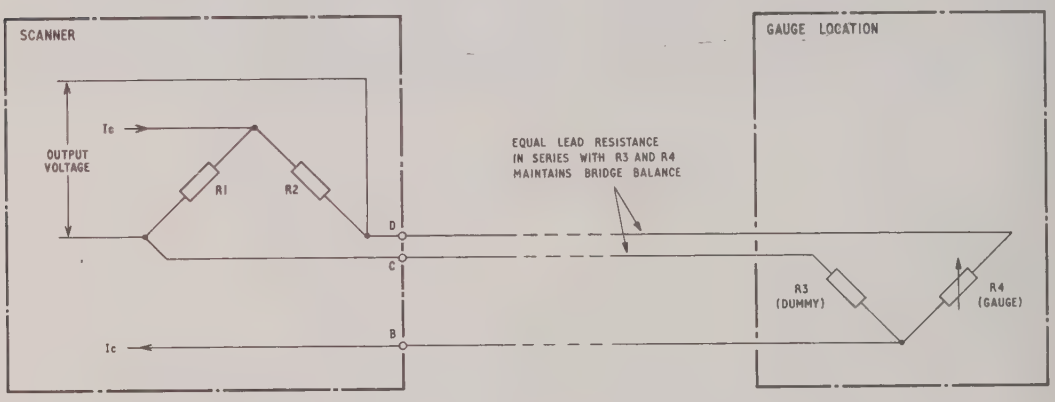


Fig. 10 Half Bridge, 3 Wire

EXAMPLE 5 (Fig. 11)

Option A - no balance - no scale - half bridge - four wire.

This configuration is used when, for practical reasons, it is required to run four leads to the remote dummy gauge and gauge, e.g. when gauge and dummy are in different locations.

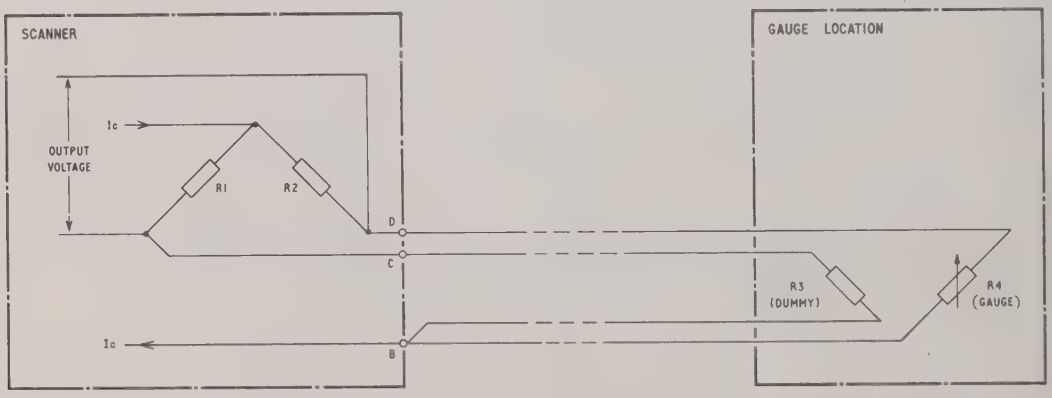


Fig. 11 Half Bridge, 4 Wire

EXAMPLE 6 (Fig. 12)

Option A - no balance - no scale - full bridge configuration.

All components of the bridge are external from the modules.

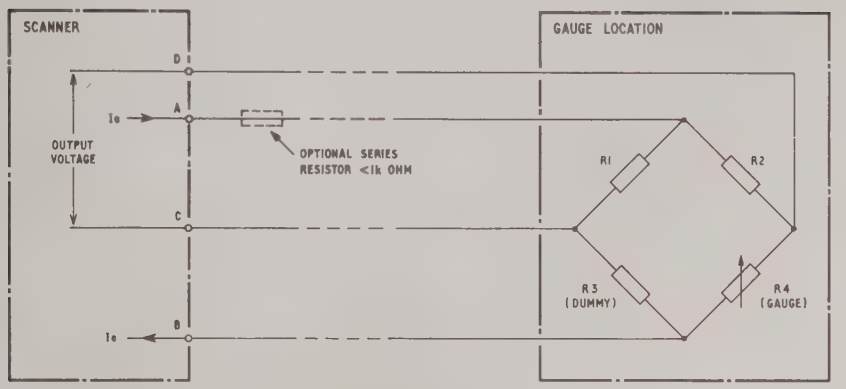


Fig. 12 Full Bridge

EXAMPLE 7 (Fig. 13 and 14)

Option B - individual balance - common scale.

Can be used in all configurations. The balance potentiometer allows the bridge circuit to be balanced for zero output or other offsets for a given strain gauge resistance. By use of the shorting links (Fig. 15) two ranges of balance can be obtained:

± 0.3% - no links
± 2% - links connected

The scale potentiometer is connected across the supply of each of the ten channels as they are selected. It provides a sensitivity adjustment of approx. 20%. See note.

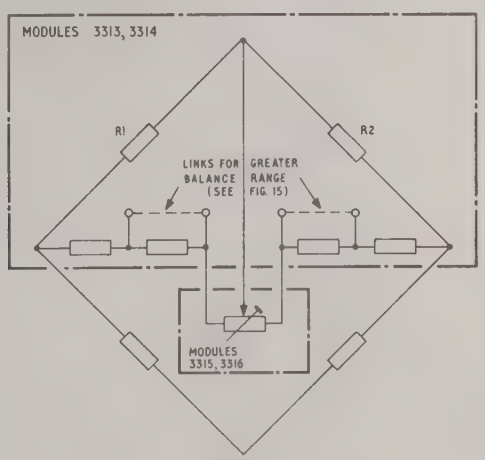


Fig. 13 Organisation of Balance Control

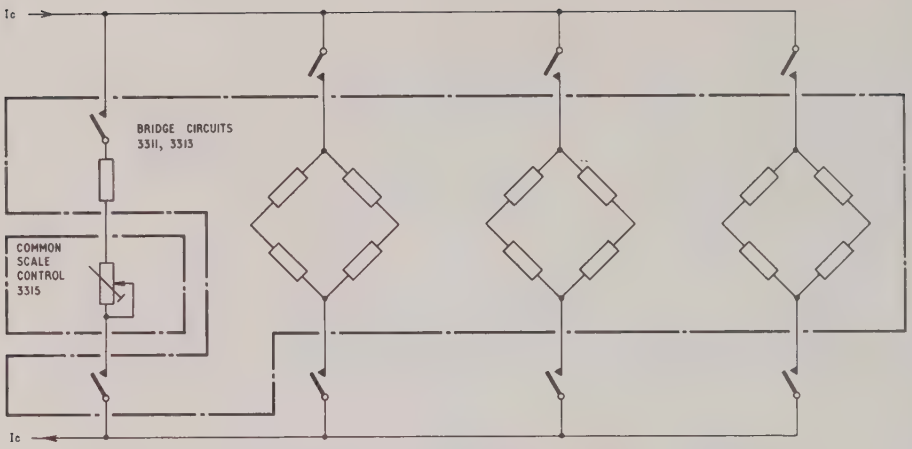


Fig. 14 Common Scale Control

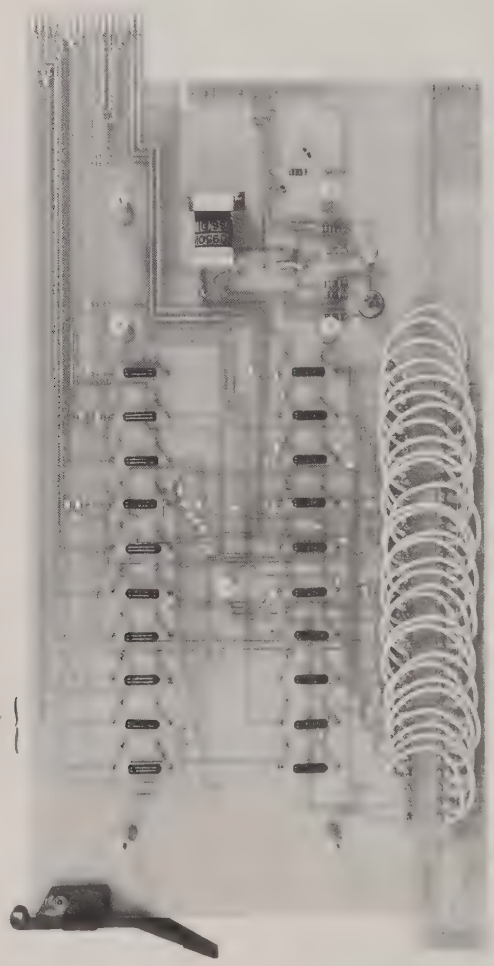


Fig. 15 Balance Range Links

EXAMPLE 8 (Fig. 13, 15 and 16)

Option C - individual balance - individual scale.

Can be used in all configurations. Each scale potentiometer is connected across the associated bridge to provide sensitivity adjustment of approx. 20%. See note.

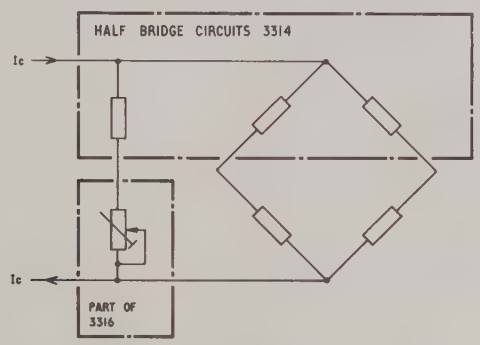


Fig. 16 Per Channel Scale Control

NOTE: Full Bridge Balance and Scale Control

The values of resistors used in remote full bridge are not defined. Consequently the range of balance and scale controls is undefined.

If the range of balance and/or scale control is insufficient, a resistor not exceeding 1000 ohms can be added in series with the positive supply lead to each full bridge. This will increase the range of control available without degrading the performance of the system.

DIGITAL CONTROL INTERFACE AND SELECTOR MODULE LINKING

Ensure that the Digital Control Interface and the Selector Modules are linked correctly. The linking depends upon the total number of inputs to the scanner, and reference should be made to Sections 5/1 and 5/2 of this Manual.

STRAIN GAUGE CALIBRATION

To calibrate a strain gauge bridge, a known change must be made, perferably a known change in gauge resistance. A convenient method of effecting this change is provided by the 3373 Calibration Switch. This switch is located behind the front panel of the strain gauge scanner. Its three positions are as follows:-

'INT CAL 10000μ STRAIN' - In this position, an internal 5.88k ohms resistor is connected across the dummy arm of the bridge, thus simulating a strain of 10,000μ strain. This assumes a gauge resistance of 120 ohms and a gauge factor of 2. For gauges having a different resistance or gauge factor, a different strain will be simulated. The value of this can be calculated from the formula:-

$$S = \frac{10^6 \times Rg}{G\,(Rg + 5880)}$$

where, S is the simulated strain in μ strain,
G is the gauge factor, and
Rg is the gauge resistance in ohms.

If a calibration value of 10,000μ strain is required for gauges other than those having a resistance of 120 ohms and a gauge factor of 2, the 'EXT CAL' position can be used.

'MEASURE' - This position is used for normal bridge measurements; no resistor is connected across the dummy arm.

'EXT CAL' - In this position, an external calibration resistor can be connected across the dummy arm, via the pair of terminals also mounted on the 3373 Calibration Switch panel. The value of the external calibration resistor, R cal, is calculated from the formula:-

$$R\,cal = Rg\left(\frac{10^6}{G \times S} - 1\right)$$

where, Rg is the gauge resistance in ohms
G is the gauge factor, and
S is the desired calibration value in μ strain.

Calibration Procedure

The calibration procedure, using the 3373 Calibration Switch, depends on the balance and scale option used. For each option, the calibration procedure appears under the appropriate heading.

Note: The DVM should be set for a resolution of 1μV.

PROCEDURE a) For systems not equipped with balance or scale potentiometers (Option A).

1. Select any one of the strain gauge channels, e.g. channel '00.
2. Adjust the strain gauge power supply until the system DVM shows a difference of '10000' when the 3373 is switched between 'calibrate' and 'measure'.
3. Switch to 'measure'.
4. Perform one complete scan of all channels to be calibrated, and record zero load values.
5. Switch to 'calibrate'.
6. Perform another complete scan and record the calibration value for each channel.
7. Switch to 'measure'. The system is now ready for use.

PROCEDURE b) For systems equipped with individual balance potentiometers, and a common scale potentiometer for each block of ten channels (Option B; 3315 Control Panel).

1. Set the strain gauge power supply to approximately 10mA.
2. Set the 3373 Calibration Switch to 'measure'.
3. Select each channel to be calibrated, in turn, and adjust the associated 3315 balance' potentiometer to give a DVM reading of zero.
4. Switch to 'calibrate'.
5. Select the first channel of the first block of ten on which calibration is being carried out.
6. Set the common 'scale' potentiometer on the associated 3315 Control Panel to its mid position.
7. Adjust the strain gauge power supply until the system DVM reads '10000'.
8. Select each of the other nine channels in the block in turn, checking for a DVM reading of '10000' in each case. Any deviations can be recorded if desired.
9. If further channel blocks are to be calibrated, leave the calibration switch on 'calibrate', and select the first channel of the next block of ten.
10. Adjust the 'scale' potentiometer on the associated 3315 Control Panel until the DVM reads '10000'.
11. Select each of the other nine channels in the block in turn, checking for a DVM reading of '10000' in each case. Any deviations can be recorded if desired.
12. Repeat operation 9. 10 and 11 until all blocks of channels are calibrated.
13. Set the calibration switch to 'measure'. The system is now ready for use.

PROCEDURE c) For systems equipped with individual balance potentiometers and individual scale potentiometers. (Option C; 3316 Control Panel).

1. Set the strain gauge power supply to approximately 10mA.
2. Set the 3373 Calibration Switch to 'measure'.
3. Select each channel to be calibrated, in turn, adjusting the associated 3316 'balance' potentiometer for a DVM reading of zero.
4. Switch to 'calibrate'.
5. Select the first of the channels on which calibration is being carried out.
6. Set the associated 3316 'scale' potentiometer to its mid position.
7. Adjust the strain gauge power supply for a DVM reading of '10000'.
8. With the calibration switch at 'calibrate', and without making any further adjustment to the power supply, select each remaining channel in turn, adjusting the associated 'scale' potentiometer for a DVM reading of '10000'.
9. Switch to 'measure'. The system is now ready for use.

Note:- The range of 'scale' control is limited, and when strain gauges with widely different parameters are used in the same system it is sometimes necessary to allocate a separate power supply to each type of gauge. In this case, when calibrating the strain gauges, adjustment must be made to the appropriate power supply.

SECTION 5/5

Power Supply Units 3317/3318

INTRODUCTION

Power supply units 3317 (Fig. 1) and 3318 provide constant current sources in the range 400μA to 30mA for strain gauge circuits.

Power supply 3317 provides a single output and power supply 3318 provides two independent outputs. The two units are similar in appearance, the 3318 having two sets of front panel controls, two sets of rear panel terminals and a different mains fuse rating.

The outputs of both units are fully isolated and guarded from the mains supply and mains earth.

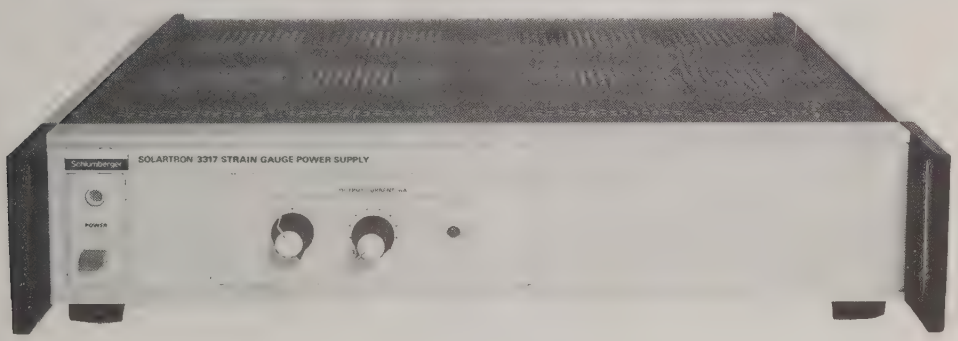


Fig. 1 Power Unit 3317

INPUT POWER

Both units are designed to operate from a supply of 115V/230V + 15% - 20%, 40 to 60Hz. A recessed three - pin plug (live, neutral and earth) is mounted on the rear panel (Fig. 2) for connection to the electricity supply. A standard mains lead is provided.

Fig. 2 Rear Panel of 3317

Input voltage selection is by means of a selector switch located on the rear panel. An input power fuse is also located on the rear panel and the fuse rating is detailed in Table 1. Only Slow Blow type fuses should be used.

Table 1

Supply Voltage	Fuse Rating	
	3317	3318
115V	200mA	250mA
230V	100mA	160mA

NOTE: Before switching on the power supply ensure that the selector switch is set to correspond with the mains voltage, and that the correct fuse is fitted.

The POWER on control is a red push-button switch located on the front panel of the unit (Fig. 3). An amber light on the front panel indicates that power is on.

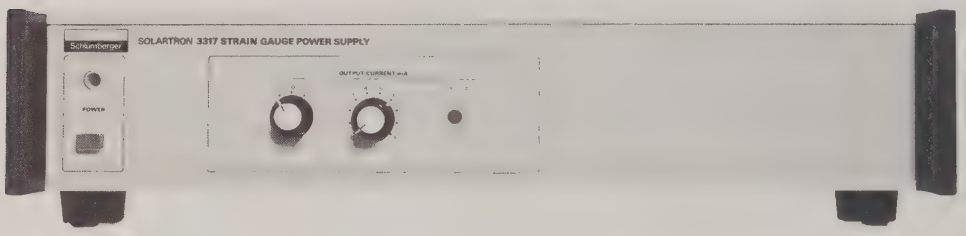


Fig. 3 Front Panel of 3317

OUTPUT CONNECTIONS (Fig. 2)

Three terminals are provided for each output. These terminals are suitable for 4mm plugs, or spade type connectors.

The terminals are located on the rear panel of the unit and are colour coded as follows:

RED	Output Current + (Current flow is out of this terminal)
BLACK	Output Current - (Current flow is into this terminal)
GREEN	Guard terminal.

Operation of the unit can be checked by connecting a 1kΩ resistor across the red and black terminals and measuring the polarity and magnitude of the voltage developed across the resistor, e.g. at a current of 1mA the voltage should be 1V with the red terminal more positive.

A standard cableform is provided for connection between the power unit output terminals and plug PLD or PLE on the scanner. This cable also provides the analogue connection between the scanner and the DVM. Cable No. 3319 is used with a DTU logger; cable No. 3329 is used with a Compact - 33 or computer based logger.

OUTPUT CONTROLS (Fig. 3)

For each output, three current controls are provided on the front panel of the unit: a three position switch changes the output current in 10mA steps from 0 to 20mA; a ten position switch changes the output current in 1mA steps from 0 to 9mA; and a multiturn potentiometer provides continuous output current adjustment in the range 400μA to 1.4mA.

For instructions on setting the controls see under Scale Adjustment in Section 5/4.

NOTE: A preset potentiometer is accessible through the rear panel. This is for setting the internal reference level and should not require further adjustment.

SECTION 5/6 Thermocouple Cold Junction Compensation Unit 3310

INTRODUCTION

The emf produced by a thermocouple (Fig. 1) is related to the difference in temperature between the 'hot' junction and the 'cold' junction. In practice, the hot junction is a temperature transducer and the cold junction the transducer connections to the measuring system, i.e., the scanner input terminals.

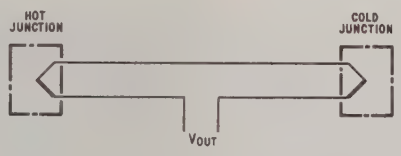


Fig. 1 Basic Thermocouple Circuit

To obtain a meaningful temperature reading, it is necessary to relate the cold junction temperature to a known reference temperature. This can be achieved in one of two ways:

a) the cold junction can be maintained at the reference temperature, or

b) any difference between the cold junction temperature and the reference temperature can be compensated for.

The second method is generally found to be the most convenient. A standard reference temperature of $0^{\circ}C$ is used, thus enabling a zero voltage transducer output to be obtained for zero temperature measurement.

Temperature compensation is carried out by a network of temperature sensitive resistors. When energised by a primary cell, the network produces an emf which corresponds to the difference between the temperature of the cold junction and $0^{\circ}C$. Both the cold junction and the compensating network are located in an isothermal compartment, the output of the compensating network being connected in series with the measuring circuit, as shown in Fig. 2. Thus, the effect of the cold junction is offset, and the resulting emf to be measured corresponds directly to the temperature of the hot junction.

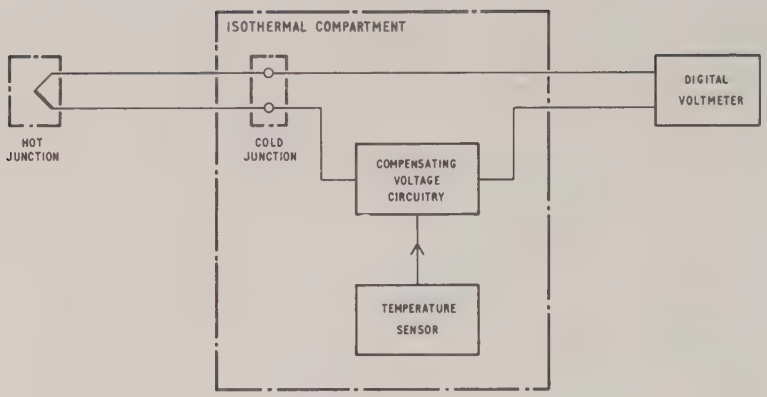


Fig. 2 Cold Junction Compensation : Simplified Block Diagram

The cold junction compensation unit 3310 (Fig. 3) provides these facilities and is fitted to the rear of the scanner when thermocouples are used.

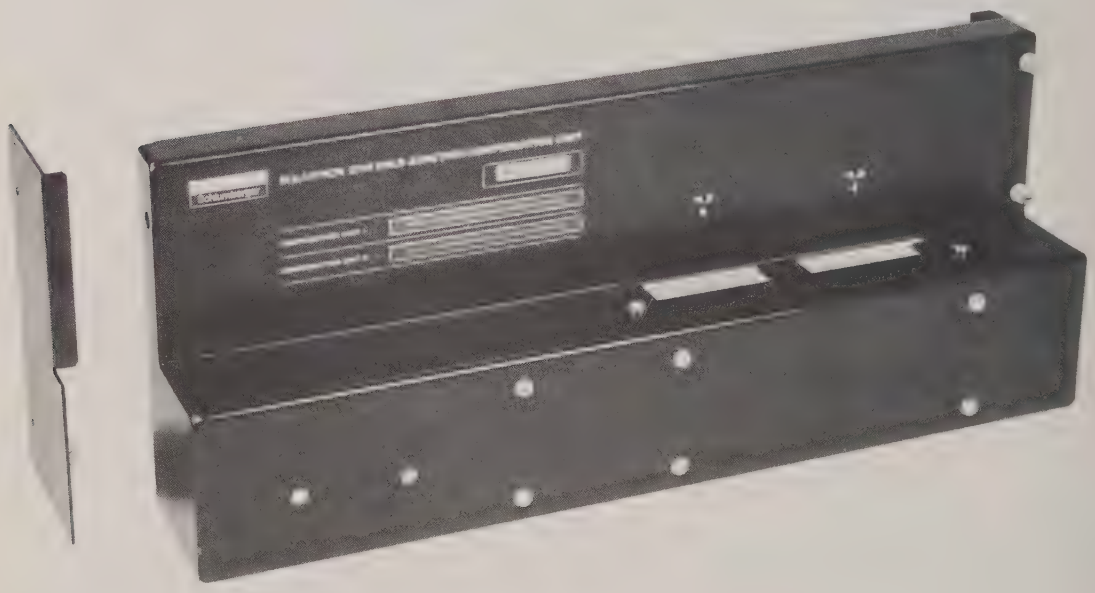


Fig. 3 Cold Junction Compensation Unit 3310

GENERAL DESCRIPTION

The unit fits onto the rear of the scanner by means of a side plate, containing two locating spigots, and two screws. At one end of the unit is mounted a socket which automatically makes the necessary internal control and analogue connections when the unit is fitted to the scanner.

At the bottom edge of the unit is a strip of thermal insulating material which allows entry for the thermocouple leads whilst retaining the isothermal conditions. Thermocouple lead connections are made at the selector module input connectors (3306) in the normal way, and these form the cold junctions. The analogue output connections are made at the sockets marked PLD and PLE on the face of the unit. These sockets replace the scanner analogue sockets which are now covered by the unit.

The unit contains two printed circuit boards and a 1.35V mercury cell. On one of these boards is soldered one or two thermocouple reference units (sense modules). Each reference unit is associated with a separate compensating circuit, thus enabling the 3310 to be used with two different types of thermocouple. The reference units determine the cold junction compensation and are selected from a range to suit the particular thermocouples in use.

Thermocouple cold junction compensation is applied to particular channels as required by programming within the scanner.

RANGE OF REFERENCE UNITS

Reference units are available for six different types of thermocouple, to three different standards, as listed in Table 1. It should be noted that the range may be amended from time to time.

Table 1

Range of Reference Units

Standard	Thermocouple
B.S. (British), DIN (German) or I.S.A. (American)	Copper/Constantan
	Nickel, Chrome/Constantan
	Nickel, Chrome/Nickel, Aluminium
	Platinum/Platinum, 10% Rhodium
	Platinum/Platinum, 13% Rhodium
	Iron/Constantan

The appropriate reference units, to suit the customer's requirements at the time of ordering, are fitted during manufacture. The type of reference unit(s) fitted to the 3310 is clearly labelled on the face panel.

FITTING A REFERENCE UNIT

If it is required to fit a reference unit proceed as follows:-

(1) Remove the 3310 from the scanner.

(2) Remove the reference unit shield plate retaining screws (four) and lift off the plate (Fig. 4).

(3) Remove the '+ O/P -' shorting link (if present) from the position at which the reference unit is to be fitted.

Note: If only one reference unit is required it should be fitted in position 1.

(4) Solder the four connections of the reference unit to the corresponding pins on the printed circuit board, using a heat shunt. The connections are clearly marked on both the reference unit and the board.

(5) Refit the shield plate and secure with the four screws.

(6) Refit the 3310 to the scanner.

(7) Attach the appropriate descriptive label (s) to the face panel for the unit (s) used.

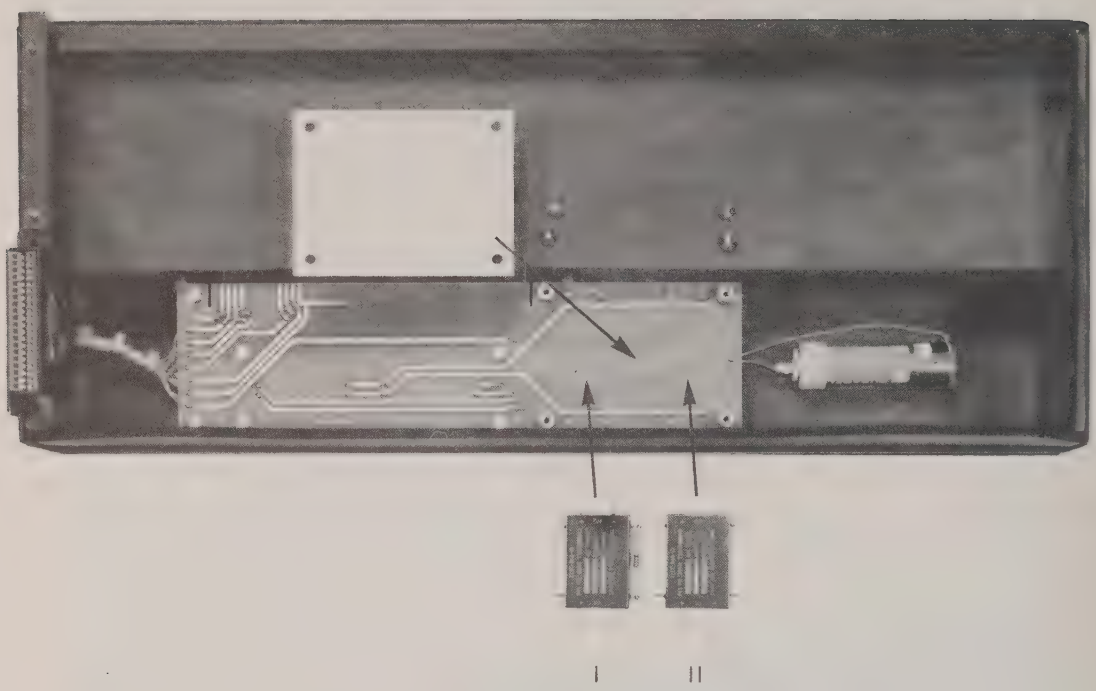


Fig. 4 Location of Reference Units

PROGRAMMING

The following facilities can be programmed:

(1) Direct e.m.f. measurement (no compensation).

(2) Cold junction compensation with reference unit No. 1.

(3) Cold junction compensation with reference unit No. 2.

Programs can be applied to blocks of ten channels (each selector module) or, where a 3309 program selector module is used, to individual channels. For programming details refer to Sections 5/1 and 5/3.

SECTION 5/7

Power Supply Unit 3377

INTRODUCTION

The 3377 Resistance Thermometer Power Supply provides an energising supply for platinum resistance thermometers, set to either 100μA or 250μA by a rear panel switch.

Power for the unit is obtained from a 115V/230V mains supply. Mains voltage selection is by means of a selector switch on the rear panel and the mains fuse rating, for each setting, is:-

(a) 115V; 200mA (SLO BLO)

(b) 230V; 100mA (SLO BLO)

CAUTION: Before switching the unit on, check that the mains selector setting corresponds with the mains voltage and that the correct mains fuse is fitted.

The POWER switch, with which the mains input to the unit is controlled, is a red push-button switch located on the front panel. Above this is an amber lamp that is illuminated when the mains is 'on'.

OUTPUT CONNECTIONS

The three output terminals provided are suitable for 4mm plugs or 'spade' type connectors, and are colour coded as follows:

RED - Output Current +

BLACK - Output Current –

GREEN - Guard Terminal

OUTPUT CONTROLS

In addition to the '100μA/250μA' output current selector switch, a 'SET 250μA' control is provided for adjusting the 250μA output current. A pre-set potentiometer, accessible through a hole in the rear panel, allows adjustment of the internal reference voltage. Both this and the 'SET 250μA' control should only be used for calibration purposes.

MP MASTER
MA24435